FEASIBILTY STUDY

FEASIBILITY STUDY REPORT

WORK ASSIGNMENT D007622-32

192 RALPH AVENUE SITE **SITE NO. 224042**
NEW YORK (C) **BROOKLYN COUNTY, NY**

Prepared for:
NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
625 Broadway, Albany, New York

Basil Seggos, Commissioner

DIVISION OF ENVIRONMENTAL REMEDIATION

URS Corporation
257 West Genesee Street
Buffalo, New York 14202

Final
December 2017

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SITE #2-24-042
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Prepared By:

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257 WEST GENESEE STREET, SUITE 400
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DECEMBER 2017

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LIST OF ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
bgs	below ground surface
CPCs	chemicals of potential concern
DER	Division of Environmental Remediation
DCE	dichloroethene
EVO	emulsified vegetable oil
ERH	electrical resistance heating
FS	Feasibility Study
gpm	gallons per minute
HHEA	Human Health Exposure Assessment
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mV	millivolts
NOD	natural oxidant demand
NYCRR	New York Code Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OM&M	operation, maintenance and monitoring
PCE	tetrachloroethene
PSA	Preliminary Site Assessment
RAOs	remedial action objectives
RI	Remedial Investigation
SCGs	standards, criteria, and guidance
SCO	soil cleanup objectives
sf	square feet
Shaw	Shaw Environmental & Infrastructure Engineering of New York, P.C.
SMP	Site Management Plan
SSD	subslab depressurization
SVE	soil vapor extraction
TCE	trichloroethene
TMV	toxicity, mobility or volume
TOGS	Technical and Operational Guidance Series
µg/L	micrograms per liter
UIC	underground injection control
URS	URS Corporation
UST	underground storage tank
VC	vinyl chloride
VOCs	volatile organic compounds
ZVI	zero-valent ion

CERTIFICATIONS

I, Donald McCall, certify that I am currently a registered professional engineer licensed by the State of New York, and that this Feasibility Study was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10) and that all activities were performed in full accordance with the DER-approved work plan and an DER-approved modifications.

074177	12-4-17	[signature]
NYS Professional Engineer #	Date	Signature

EXECUTIVE SUMMARY

This Feasibility Study (FS) report was prepared by URS Corporation (URS) for the 192 Ralph Avenue site, located in Brooklyn, the City of New York, Kings County, New York. The site was historically used for a dry cleaning service. Tetrachloroethene (PCE) was used in dry cleaning operations as a cleaning solvent. Results of the Remedial Investigation (RI) prepared by Shaw Environmental & Infrastructure of New York, P.C. (Shaw) (September 2015) and previous investigations indicated the presence of PCE and related degradation products in soil, soil vapor, indoor air, and groundwater at the site and adjacent properties. A soil vapor extraction (SVE) system was installed at the Ralph Avenue property in 2008 and appears to have mitigated contamination levels to concentrations acceptable to the New York State Department of Environmental Conservation (NYSDEC). The horizontal extent of volatile organic compounds (VOCs) in soil has been delineated.

Based on investigations performed to date, the horizontal extent of groundwater contamination has been delineated. PCE and its degradation products (e.g., trichloroethene [TCE], *cis*-1,2-dichloroethene [*cis*-1,2-DCE], and *trans*-1,2-dichloro-ethene [*trans*-1,2-DCE]) have migrated offsite via groundwater. VOC contamination has exceeded applicable standards, criteria, and guidance (SCGs) in groundwater.

The remedial goal for the site is to eliminate or mitigate all significant threats to public health and the environment presented by the contaminants disposed at the site. Numerical cleanup goals for the site are based on Part 375 criteria for unrestricted use. To meet the remedial goal for the site, the following RAOs were established:

For Public Health Protection:

- Prevent ingestion of groundwater with contaminant levels exceeding drinking water quality standards.
- Prevent contact with, or inhalation of volatiles, from contaminated groundwater.

For Environmental Protection:

- Restore groundwater aquifer to pre-disposal/pre-release conditions, to the extent practicable.

In order to meet the remedial goal and remedial action objectives for the site, the following remedial alternatives were developed:

- Alternative 1 – No Further Action
- Alternative 2 – No Action with Continued Groundwater Monitoring
- Alternative 3 – In Situ Treatment of Highest Concentrations Portions of Plume
- Alternative 4 – In Situ Treatment of Entire Plume

These alternatives were evaluated against the NYSDEC criteria: Overall Protection of Public Health and the Environment; Compliance with Standards; Criteria and Guidance; Long-term Effectiveness and Permanence; Reduction of Toxicity, Mobility and Volume with Treatment; Short-term Effectiveness; Implementability; Land Use; and Cost. Based on the evaluation, Alternative 2 is the recommended remedy for the site with a total present worth cost of about $110,000. It includes the following components.

- Nine existing groundwater monitoring wells shown in Figure 5-1 would be sampled annually and analyzed for VOCs.

- Additional soil vapor intrusion sampling would be performed as necessary in accordance with the Site Management Plan

1.0 INTRODUCTION

1.1 Contract Authority

URS Corporation (URS) prepared this Feasibility Study (FS) report for the 192 Ralph Avenue site located in Brooklyn, the City of New York, Kings County, New York. The report was prepared for the New York State Department of Environmental Conservation (NYSDEC) under the State Superfund Standby Contract, Work Assignment D007622-32.

1.2 Scope of Feasibility Study

This FS report evaluates the remedial action for the contaminants found to be present at and in the vicinity of the site. This FS was developed to meet the requirements set forth in the New York State Code Rules and Regulations (NYCRR) 6 NYCRR 375, and NYSDEC Department of Environmental Remediation (DER) DER-10 Technical Guidance for Site Investigation and Remediation. This FS specifies the remedial goal and remedial action objectives, identifies potential remedial technologies feasible for use at this site, and develops remedial alternatives that meet the remedial action objectives. Remedial alternatives will be evaluated in sufficient detail such that the NYSDEC can prepare a Proposed Remedial Action Plan and issue a Record of Decision.

1.3 Report Organization

This document has been organized consistent with NYSDEC DER-10 and includes the following sections:

- Executive Summary.
- Introduction.
- Site Description and History.
- Remedial Goal and Remedial Action Objectives.
- Identification and Screening of Remedial Technologies.
- Development and Description of Alternatives.
- Detailed Analysis of Alternatives and Recommended Remedy.

2.0 SITE DESCRIPTION AND HISTORY

This section presents a site description and a summary of site conditions and site history.

2.1 Site Description

192 Ralph Avenue (site #224042) is located in the Bedford-Stuyvesant section of Brooklyn, New York. The site investigation was performed in the area along Ralph Avenue between the main thoroughfares of Macon Street to the north, Marion Street to the south, Patchen Avenue to the west, and Howard Avenue to the east (Figure 2-1). This area defines "the site" as referred to in this report. There is currently a small single-story building on the site. The building shares its side walls with a three story building to north and a four story building to the south. Surrounding land uses include commercial and residential.

2.2 Site History

From approximately 1946 to 1998, the 192 Ralph Avenue property was operated by a dry cleaner. After removing the concrete basement floor as part of an initial subsurface investigation in 2002, it was determined that contamination at the Site was directly related to the former dry-cleaning facility operations. A Remedial Investigation (RI) in 2006 and a Supplemental Investigation in December 2007 under the Voluntary Cleanup Program (VCP) revealed that soil vapor was impacting indoor air quality on and adjacent to 192 Ralph Ave. In January 2008 the VCP called for the installation of a soil vapor extraction (SVE) system and a vapor barrier beneath the former dry-cleaners, and an SVE system beneath the adjacent management office. An SVE system was installed at the 192 Ralph Avenue property in 2008 and appears to have mitigated indoor air contamination levels to concentrations acceptable to the NYSDEC.

An off-site investigation was not conducted under the VCP. In 2010, the NYSDEC requested that Shaw Environmental & Infrastructure of New York, P.C. (Shaw) perform a RI to determine the extent of impacts that were originating from the 192 Ralph Avenue property.

The contaminants of concern at the 192 Ralph Avenue VCP Site include tetrachloroethene (PCE), trichloroethene (TCE), and associated breakdown products. Contaminants of concern had been detected in soil, soil gas, indoor air, and groundwater in both on and off-site areas in concentrations exceeding applicable guidance values.

In April 2012, NYSDEC issued a work assignment to Shaw for additional RI work to investigate any off-site impacts related to the VCP site. Shaw submitted the subsequent Final Remedial Investigation Report in September 2015.

2.3 Site Geology

The Site is located in the Atlantic Coastal Plain Physiographic Province. The Pre-Cambrian Age metamorphic bedrock is believed to be over 200 feet below ground surface (bgs) at the Site. The geology of the Site consists of outwash sand and gravel deposits. The soils at the Site have been classified as urban fill consisting of construction debris, rock, and ash. The urban fill reaches approximately 7 feet bgs, underlain by glacial deposits consisting primarily of silt, sand, and gravel.

Between December 10, 2012 and January 17, 2013, Shaw advanced 10 soil borings (SB-1 through SB-10) to a maximum depth of 65 feet bgs (Figure 2-2). Soil types encountered at the borings installed during the RI were generally tight silty sands that transitioned to loose, well-sorted coarse sands below 20 feet bgs. During advancement refusal was encountered at three locations: SB-4, SB-6, and SB-8. Refusal at SB-4 was near 13 feet bgs at the original location and 12.5 feet bgs after the point was relocated four feet south. This point was relocated for a third time directly across Decatur Street to the north where it was successfully advanced to 50 feet bgs. At SB-6, refusal was encountered once at 15 feet bgs, but the boring was successfully advanced after moving the point three feet to the west. Refusal at SB-8 occurred at 35 feet as the sample rods were being lowered to retrieve a soil core from the 40-45-foot bgs interval. This was likely due to the saturated coarse sands collapsing upon rod retrieval due to a lack of cohesion within the soil.

These studies found highly permeable fine to medium sands with some gravel appearing above a confining layer of silty clay at about 60 to 70 feet bgs.

2.4 Site Hydrogeology

Groundwater is present in the fill and glacial deposits, occurring at depths of approximately 35 to 40 feet bgs.

A total of nine monitoring wells (MW-1 through MW-5 and MW-7 through MW-10) were installed at the site depths of approximately 50 feet bgs. Each well was constructed with 10 feet of 0.01-inch slotted screen. Due to a low groundwater gradient, a contour map could not be produced from the gauging results obtained during the February 2013 visit. Specifically, the change in water table elevation across the area is 0.56 feet; this flat elevation, combined with the relatively small size of the Site, topography, and paving of the Site all combine to make the development of meaningful groundwater contours problematic. The data shows a groundwater flow direction toward the southeast, which is generally consistent with historic gauging data.

2.5 Previous Investigations

A Voluntary Cleanup Program Investigation was performed during the period 2002 – 2008. An Initial Subsurface Investigation was conducted in 2002. After removing the concrete basement floor, it was determined that contamination at the Site was directly related to the former dry cleaning facility operations. A RI in 2006 and a Supplemental Investigation in December 2007 revealed that soil vapor was impacting indoor air quality on and adjacent to the site. In January 2008, the VCP called for the installation of an SVE system and a vapor barrier beneath the former dry cleaners, and an SVE system beneath the adjacent management office.

2.6 Potentially Applicable Standards, Criteria, and Guidance

Potentially applicable standards, criteria, and guidance (SCGs) for the site consist of Part 375: Remedial Program Soil Cleanup Objectives (SCOs) that were used as the basis for evaluating remedial alternatives in this FS. There are seven categories of SCOs in Part 375. These categories include the following: unrestricted use, residential use, restricted residential use, commercial use, industrial use, protection of ecological resources, and protection of groundwater. Unrestricted use criteria are considered the most appropriate for the site and these SCOs were used to develop and evaluate alternatives in this FS.

Groundwater standards are set by the Class GA standards presented in NYSDEC TOGS 1.1.1, April 2000.

There are no applicable regulatory criteria for soil vapor contamination. However, because PCE and TCE are common soil and groundwater contaminants, the New York State Department of Health (NYSDOH) has established air guidelines for indoor air concentrations of these compounds to assist in determining whether actions should be taken to reduce potential exposures to contaminants from soil vapor intrusion.

2.7 Nature and Extent of Contamination

The nature and extent of contamination was delineated in the RI Report prepared by Shaw in September 2015. A summary of the RI findings is presented in this section.

2.7.1 Soil

Figure 2-2 shows the location of soil samples collected during the RI. Analytical results from soil did not indicate the presence of contaminants of concern or any other analytes above SCO guidelines for unrestricted use.

2.7.2 Groundwater

Figure 2-3 shows the locations of groundwater samples collected during the RI and in more recent January 2016 sampling and the results that exceed the groundwater SCGs. PCE was detected in all monitoring well samples and exceeded groundwater SCGs in all but two of those samples. PCE levels increase in concentration toward the southwest, away from 192 Ralph Avenue. Additional analytes detected in groundwater include TCE, cis-1,2-DCE, and trans-1,2-DCE, with concentrations exceeding groundwater SCGs in several samples. Chloroform was also detected in all groundwater samples collected, exceeding guidance values in five sample locations (MW-3, PZ-2, MW-2, PZ-5, and PZ-4).

2.7.3 Soil Vapor

Figure 2-4 shows the locations where soil vapor samples were collected. PCE was the only VOC detected and was found in all soil vapor sampling points and the ambient air sample collected during the February and September 2013 sampling events. PCE concentrations increased toward the southwest, away from 192 Ralph Avenue.

2.7.4 Indoor and Subslab Air

Owners of five structures agreed to sampling for indoor and subslab air contamination. These locations are shown on Figure 2-5. Two locations had PCE detections in samples above the NYSDOH "Guidance for Evaluating Soil Vapor Intrusion in the State of New York" (NYSDOH, 2006) [NYSDOH VI Guidance]. Combinations of sub-slab soil gas and indoor air results at the structure located at the corner of Decatur St. and Ralph Ave. fell within the range that NYSDOH VI Guidance recommends "mitigation". A mitigation system was offered to the owner of this location.

2.8 Qualitative Human Health Exposure Assessment

2.8.1 Potentially Exposed Receptors

The previous and current use of the site is commercial. The area immediately surrounding the site is mixed-use commercial/residential. The future use of the site and downgradient properties is anticipated to be the same as the current use.

Currently, there are no known potable wells within the immediate vicinity of the site. New York City supplies potable water to residences in this area from a network of reservoirs in the Croton, Catskill, and Delaware Watersheds.

Under both the current and future use scenarios, potentially exposed receptors include commercial workers in buildings located at and near the site, nearby residents, other workers (e.g., construction) at and in the vicinity of the site, and trespassers. Additionally, residents in residential structures above the plume that did not permit indoor air sampling may be exposed to solvent vapors.

The potential future use includes continued commercial and residential use, including possible future construction activities. Thus, construction workers have also been identified as potential receptors if construction occurs at the property in the future. Residents or site workers could be exposed through groundwater ingestion if wells were installed near the site and the water was used for human contact and/or consumption.

2.8.2 Exposure Pathways

Under the current use scenario, exposure to site-related contaminants via indoor air was identified as a completed exposure pathway for some receptors. While direct exposure to contaminated groundwater is not considered to be a completed exposure pathway under the current use scenario, these media contribute to the contaminated soil vapor.

Under the future use scenario, exposure to site-related contaminants via groundwater and indoor air are identified as potentially completed exposure pathways for some potential receptors. Exposure may occur during potential commercial or residential construction efforts on the site or at nearby residences. Ingestion, dermal absorption, and inhalation of VOCs are potential exposure pathways if contaminated media are exposed. Indoor air contamination directly caused by groundwater contamination would continue to pose an inhalation exposure threat in the absence of mitigation systems.

3.0 REMEDIAL GOAL AND REMEDIAL ACTION OBJECTIVES

3.1 Remedial Goal

In accordance with DER-10, the remedial goal for site remediation is as follows:

- The remedy will eliminate or mitigate all significant threats to public health and the environment presented by the contaminants disposed at the site. To the extent possible, the remedy would restore the site to pre-disposal conditions.

3.2 Remedial Action Objectives

In order to meet the remedial goal, remedial action objectives (RAOs) were developed to protect public health and the environment and provide the basis for selecting technologies and developing alternatives. In order to develop site-specific RAOs, the generic RAOs presented in DER-10 were considered for the potential mediums of concern (groundwater and soil vapor/indoor air). Table 3-1 presents a summary of the generic RAOs and the rationale for site-specific RAO selection. The site-specific RAOs are presented below.

Groundwater: As shown in Figure 2-3, some groundwater samples exhibited VOC contamination above Class GA SCGs. The RAOs for groundwater are:

For Public Health Protection:

- Prevent ingestion of groundwater with contaminant levels exceeding drinking water quality standards.
- Prevent contact with, or inhalation of volatiles, from contaminated groundwater.

For Environmental Protection:

- Restore groundwater aquifer to pre-disposal/pre-release conditions, to the extent practicable.

Soil Vapor/Indoor Air: Sampling has identified some structures that contained VOC vapors in or below structures at levels that resulted in actions being taken to reduce potential exposures to contaminants through soil vapor intrusion. The RAO for soil vapor/indoor air is:

For Public Health Protection:

- Mitigate impacts to public health resulting from existing, or the potential for, soil vapor intrusion into buildings at the site.

3.3 Areas of Contamination Addressed

Based on the RI results summarized in Section 2 and the RAOs presented in the previous sections, the areas and depth (as appropriate) of contamination addressed by this FS are described in the following sections.

3.3.1 Groundwater

Groundwater contamination addressed by this FS is defined by the extent of the observed plume which extends from the source at 192 Ralph Ave to approximately 800 feet to the south/southwest. Groundwater contamination extends from the top of the water table, at approximately 35 to 40 feet bgs, to approximately 50 feet bgs.

3.3.2 Soil

Analytical results from soil matrices did not indicate the presence of contaminants of concern or any other analytes above SCO guidelines. Therefore, no further action for soil is required.

3.3.3 Soil Vapor/Indoor Air

PCE was detected in all soil vapor sampling points (Figure 2-4) and the ambient air sample collected during the February and September 2013 sampling events. Soil gas PCE concentrations were highest (greater than 1,000 $\mu g/m^3$) adjacent to the 192 Ralph Avenue source and in several soil gas points located within 600 feet downgradient of the source. There was only limited participation by area building owners and tenants during indoor air sampling, but four of the five structures tested had detectable levels of PCE in subslab vapors, but PCE was not detected inside the structures. Targeted areas for Soil Vapor/Indoor Air remediation are not defined. Soil vapor concentrations would be reduced through reductions of groundwater concentrations, and structures would be mitigated on a case by case basis depending on indoor and subslab vapor concentrations. Currently, only one structure at the intersection of Decatur St.

and Ralph Ave. exhibits subslab PCE concentrations above the threshold established by NYSDOH for implementation of mitigation activities.

NYSDEC will continue to provide indoor air testing for structures located above the plume and provide subslab depressurization (SSD) systems to those structures that exceed the criteria published by NYSDOH for mitigation systems. Therefore, no further action for Soil Vapor/Indoor Air is required other than actions taken to reduce the size and concentration of the groundwater plume.

3.4 General Response Actions

General response actions are broad response categories capable of satisfying the remedial action objectives for the site.

No Further Action: A no further action response provides a baseline for comparison with other alternatives and includes the ongoing vapor intrusion mitigation program.

Institutional Controls: Institutional controls, such as environmental easements and Site Management Plans, are measures to provide protection to human health and the environment by identifying contamination and reducing exposure.

Exposure Point Mitigation: Remedial measures may be implemented at the point of exposure to mitigate exposure to contaminated material and provide adequate protection to human health and the environment.

Containment: Containment measures are those remedial actions whose purpose is to contain and/or isolate contaminants. These measures prevent migration from, or direct human exposure to, contaminated media without treating, disturbing or removing the contamination.

Removal: Removal measures remove contamination from the subsurface for subsequent treatment and/or disposal.

Treatment: Treatment measures include technologies whose purpose is to reduce the toxicity, mobility, or volume of contaminants by directly altering, isolating, or destroying those contaminants.

4.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

This section identifies specific remedial technologies for the affected medium (groundwater) and evaluates them with respect to their effectiveness and technical implementability in meeting the RAOs for this site. Appropriate technologies will be carried forward into the development of alternatives.

4.1 Identification of Technologies

This section identifies remedial technologies for groundwater, the only medium identified above for treatment. Technologies are identified according to the general response actions presented in Section 3.4.

4.1.1 Institutional Controls

Institutional controls would provide no action towards remediating groundwater contamination, but would include an environmental easement(s) and a Site Management Plan (SMP) which may be used in conjunction with, or in the absence of, remedial measures. Currently, groundwater onsite and near the site is not utilized for potable purposes. Potable water is provided to all residents and commercial establishments in the area by New York City. Institutional controls would:

- Require compliance with the approved SMP.
- Limit the use and development of the properties to specific uses (e.g., unrestricted use, commercial use).
- Prohibit groundwater use without treatment rendering it safe for its intended purpose and approval by NYSDOH.
- Include requirements to complete and submit to the NYSDEC periodic certification with long-term monitoring results.
- Identify procedures for characterization, handling, and the health and safety of workers and the community who come into contact with the low levels of contaminated groundwater in the event of intrusive subsurface activity at the site.

Effectiveness: Institutional controls with an SMP and an environmental easement would be effective in meeting the RAOs of preventing ingestion of groundwater with contaminant levels exceeding drinking water standards, and preventing contact with groundwater contaminated with VOCs during future construction activities, but would not be effective in meeting the RAO of restoring the aquifer to pre-disposal/pre-release conditions.

Implementability: Institutional controls would not be difficult to implement considering that potable water is provided by New York City.

Cost: The cost for institutional controls would be relatively low.

Conclusion: Institutional controls are retained for use at the site.

4.1.2 Exposure Point Mitigation

Because groundwater is not used for personal consumption in the vicinity of the site, Exposure Point Mitigation technologies are not applicable.

4.1.3 Containment

Groundwater containment technologies aim to limit the migration of contaminated groundwater. Containment can be accomplished through physical isolation or hydraulic control. Primary physical containment technologies are the installation of sheet piling or slurry walls. These technologies are particularly effective on small source areas that have not migrated significantly. Hydraulic containment comprises extraction well(s) to reverse natural hydraulic gradients to prevent plume migration. Extracted groundwater typically requires treatment prior to discharge.

Effectiveness: Contamination has migrated sufficiently far to have impacted adjacent residences through the vapor intrusion exposure pathway. Therefore, containment would not be effective in mitigating the impacts from this plume. Although it may prevent the further spread of contamination from the site, it would not provide a significant exposure reduction.

Implementability: It would be difficult to construct and maintain containment measures over a long time period due to infrastructure in the vicinity of the site including buildings, roadways, and subsurface utilities.

Cost: Containment construction costs are moderate to high.

Conclusion: Containment technologies will not be retained for consideration.

4.1.4 Removal

Groundwater contamination can be removed either as a liquid (groundwater removal) or by being volatilized and removed as a vapor through air sparging or electrical resistance heating.

4.1.4.1 Groundwater Extraction and Treatment

Extraction via pumping wells is the typical method for groundwater removal as a liquid. Collection trenches installed perpendicular to the plume flow direction have also been used for groundwater removal. Removed groundwater would have to be treated prior to discharge. For the low levels of PCE present in the groundwater, treatment would typically be carbon adsorption.

Effectiveness: Although hydraulic conductivity information is not available, the reported coarse sand nature of the aquifer materials would allow for a large radius of influence for extraction wells. Regardless, groundwater extraction would be of limited effectiveness at this site because of the large and dispersed nature of the plume.

Implementability: Groundwater extraction would be difficult to implement because of the urban nature of the site. A network of wells would have to be installed over two to three blocks and extracted water piped to a treatment facility. It would be difficult to site the wells, pumping network, and treatment plant within a fully developed urban environment.

Cost: Groundwater removal through extraction wells has high capital cost, and would have to operate for a very long time (decades) and thus would incur significant operating costs.

Conclusion: Groundwater removal through an extraction well(s) will not be retained for consideration because of the implementability limitations.

4.1.4.2 Air Sparging

Air sparging removes VOCs from groundwater by injecting air into the aquifer, transferring the VOCs into the air, and then collecting the air with a vapor extraction system. The air would be sparged into the saturated zone below 35 feet bgs and collected using separate vapor extraction wells installed in the vadose zone.

Effectiveness: Contaminants at the site are amenable to removal via air sparging. The coarse sand aquifer material is amenable to an even distribution of sparged air and subsequent uniform treatment.

Implementability: Air sparging requires a tight, regular pattern of injection points. The urban nature of the site would limit the ability to implement this requirement. A greater barrier to implementation is the need to install the vapor extraction points to recover the vapors. Inability to effectively place these points uniformly to capture all generated vapors could lead to greater vapor intrusion exposure pathways.

Cost: The cost for air sparging would be moderate.

Conclusion: Removal via air sparging will not be retained for consideration because of the implementability limitations.

4.1.4.3 Electrical Resistance Heating

Electrical Resistance Heating (ERH) transfers VOCs in groundwater into the vapor phase through heating rather than sparging. Steel electrodes are installed into the subsurface to the maximum depth of contamination in a regular pattern. Electricity is passed from electrode to electrode, using the saturated zone as a conductor. Because the saturated zone is merely an adequate conductor, it provides sufficient electrical resistance. Power in the electrical current is dissipated as heat. This heat causes the groundwater to boil, stripping out the more volatile contaminants. The VOCs and steam are collected by a vapor recovery system similar to, but larger in scope (to accommodate the steam), than that which would be employed with air sparging.

Effectiveness: ERH is more effective than air sparging as it is not dependent on uniform flow of sparged air. Volatilization occurs as a result of heat transfer, which is not affected by soil permeability. The contaminants present at the site are amenable to volatilization via ERH.

Implementability: The same barriers to implementation that exist for air sparging would exist for ERH. Electrodes would have to be installed in a regular pattern, and a robust vapor recovery system would be required throughout the treatment area. Such a vapor recovery system to capture vapor phase VOCs released during the ERH process would be difficult to effectively construct beneath the buildings.

Hundreds of kilowatts of power are required to implement ERH. Such capacity may not be available from the local grid.

Cost: The cost of ERH with a vapor recovery system is moderate to high.

Conclusion: ERH will not be retained for further consideration because of the implementability limitations.

4.1.5 Treatment

Treatment technologies destroy contaminants, converting them to less toxic end products. Organic contaminants at the site can be converted through oxidation or reduction processes.

4.1.5.1 In Situ Chemical Oxidation

In situ chemical oxidation (ISCO) uses oxidants delivered into the saturated zone to oxidize the contaminants to innocuous compounds such as water, carbon dioxide, and chloride ions. The three principal oxidants used in environmental remediation are Fenton's reagent, permanganate, and activated persulfate. Within these chemical approaches there are proprietary oxidants such as RegenOx™, Klozur®, and Cool-Ox™ .

Effectiveness: All ISCO approaches are dependent upon aqueous phase contact between the delivered oxidant materials and the contaminant. Therefore, the ability to achieve adequate subsurface distribution closely determines the effectiveness of the approach. The aquifer material below the water table is described as coarse sand which should allow efficient distribution of the injected reagents.

Fenton's reagent, permanganate, and activated persulfate are effective in oxidizing the contaminants at the site; all have the ability to treat the chlorinated compounds present. Permanganate presents some advantages over Fenton's reagent and persulfate. Although a relatively weaker oxidant than the other two options, it is strong enough for oxidizing the contaminant concentrations present at the site. In contrast, permanganate is a longer-lasting oxidant. It has the potential to remain active in the subsurface for months, allowing it to diffuse and otherwise travel into the lower permeability zones more effectively.

Implementability: Like other in situ treatment technologies, injection of ISCO reagents using low-pressure injection techniques requires a regular pattern of injection points. However, in contrast to air sparging and ERH, ISCO treatment with a long-acting oxidant such as permanganate can tolerate implementation via a less than ideal injection pattern due to diffusion and convection of the reagent.

Multiple injection events would be required with limited site access for each event. Temporary equipment would be mobilized to the site and could be located along public rights of way to reduce impacts to business operations during each event.

Cost: The costs for ISCO are moderate.

Conclusion: Treatment via ISCO will be retained for consideration. For the development and analysis of remedial alternatives, oxidation by permanganate will be selected as the process option for the analysis since it is effective and longer lasting. Low-pressure injection methods will be considered in this option as the delivery method.

4.1.5.2 In Situ Reduction

In situ reduction can be implemented using biological and/or non-biological mechanisms. Both include the sequential dechlorination of target compounds where one chlorine atom is removed at a time, from the starting compound to innocuous end products. Amendment materials used to implement in situ reduction include the following, alone or in combination:

- Biostimulants (e.g., electron donor materials use to create suitable anaerobic aquifer conditions and provide microbial food) such as emulsified vegetable oil (EVO), soluble plant carbon, and sodium lactate-based materials;

- Chemical reducing agents (e.g., where reduction occurs on the contact of the material and may also be used to establish reducing aquifer conditions) such as zero-valent iron materials; and

- Microbial culture (e.g., introduction of laboratory grown bacteria known to degrade target contaminants) such as *Dehalococcoides* (DHC), which is typically only introduced following aquifer conditioning to anaerobic conditions.

For aquifer conditioning and biostimulation, EVO products include: EOS® from EOS remediation, SRS™ from Terra Systems, Inc., and Newman Zone® from Remediation and Natural Attenuation Services, Inc. Each of these products consists principally of a vegetable oil mixture that has been emulsified to serve as a long-term carbon source (acting as an electron donor) and small amounts of sodium lactate for short-term biostimulation, and a variety of other additives and vitamins.

Products in the sodium lactate electron donor category include HRC® products from Regenesis and WilCLEAR® by JRW Bioremediation. The HRC® products typically have increased longevity within the subsurface (months to years); whereas WilCLEAR® is a quickly dissolving lactate solution that is typically consumed very rapidly (weeks to months).

Chemical reducing materials include zero-valent iron (ZVI), a granular or powdered material proven to degrade target compounds such as PCE and TCE via reductive dechlorination. Surface contact is required between the target contaminant and the ZVI material surface. Products such as BOS 100 from Remediation Products, Inc. utilize granular activated carbon (e.g., non-soluble carbon for contaminant adsorption) with iron precipitates on the carbon surface to facilitate abiotic reduction. Treatment using ZVI with abiotic dechlorination alone requires substantial subsurface distribution for contact between the contaminant and the ZVI materials. Therefore, this would typically be implemented using a permeable reactive barrier or very tight spacing across the target treatment area.

Additionally, ZVI can be used for aquifer conditioning, primarily in the ability of ZVI to create reducing conditions (e.g., ORP of less than –200 millivolts [mV]). Several products combine ZVI with an electron donor to support both abiotic and biological dechlorination processes. These combination products include EHC® (e.g., soluble plant carbon and ZVI) from Adventus Americas, Inc. and EZVI (nano-scale ZVI suspended in emulsified oil) from TEA, Inc.

Following biostimulation or aquifer conditioning activities, bioaugmentation, using laboratory grown culture, may be necessary to meet SCGs and/or remedial action objectives. Microbial cultures for reductive dechlorination are commercially available from several vendors including KB-1® from SiREM and Bio-Dechlor INOCULUM® from Regenesis. Microbial cultures are typically introduced once suitable aquifer conditions have been established (e.g., ORP of less than –100 mV and pH between 6 and 8).

The majority of in situ reduction materials presented above rely on microbiological activity to perform complete dechlorination. Dechlorinating bacteria have been found at many sites naturally, even where aquifer conditions may not be suitable for complete degradation to occur. Only very limited dechlorination has been observed to be naturally occurring at the site, and therefore, it is likely that bioaugmentation may be required.

Effectiveness: In situ reduction materials presented above are effective in dechlorinating the chlorinated contaminants present at the site, provided adequate subsurface distribution is achieved. As with ISCO, many electron donors have greater longevity. Bacteria predominantly reside on soil particles and self-distribute (i.e., bloom) as aquifer conditions become suitable. At other sites, this has allowed greater distribution over time increasing treatment effectiveness. As with ISCO, low-pressure injection methods are anticipated to be the most suitable delivery method.

Reduction treatment requires an anaerobic environment and low redox potential. Currently, the aquifer is aerobic with a high redox potential. Addition of electron donors consumes the dissolved oxygen and lowers the redox potential. However, the aerobic nature of the aquifer may limit the effectiveness of the reagent as it migrates by diffusion and convection from the injection point.

Implementability: Implementability of in situ reduction is defined by the same benefits and constraints as ISCO. Specifically, while injection on a regular geometric pattern is preferable (yet difficult to achieve in an urban environment), reduction reagents, especially EVO, are long-lived and thus can reach additional area through diffusion and convection.

Cost: The costs of in situ reduction are moderate.

Conclusion: Treatment via in situ reduction will be retained for consideration. For the development and analysis of remedial alternatives, biostimulation using an EVO will be selected as the process option considered for the analysis. Bioaugmentation may be included with this option. Low-pressure injection will be included as the delivery method.

4.1.5.3 Natural Reductive Dechlorination

Natural Reductive Dechlorination occurs when there are sufficient electron donors present in the aquifer and the redox levels are sufficiently low, that naturally occurring microflora dehalogenate the chlorinated organics, eventually leading to the destruction of the contaminants in the plume.

Effectiveness: The dissolved oxygen concentrations observed during groundwater sampling averaged approximately 6 mg/L, indicating aerobic conditions. TCE is the first degradation product of PCE, and is present in only very low concentrations. This indicates that natural reductive dechlorination is not occurring.

Implementability: This technology is easy to implement. A groundwater monitoring program utilizing existing monitoring wells could be implemented to document effectiveness.

Cost: There is no cost associated with natural reductive dechlorination other than continued monitoring.

Conclusion: Since natural reductive dechlorination is not occurring at the site, it will not be considered a remedial technology.

4.2 Summary of Remedial Technologies

Remedial technologies retained for use in the development of alternatives include:

Groundwater:

- No Action
- Institutional Controls
- In Situ Chemical Oxidation
- In Situ Reduction

5.0 DEVELOPMENT AND DESCRIPTION OF ALTERNATIVES

This section combines the remedial technologies considered feasible into remedial alternatives for the site. The alternatives are then described.

5.1 Development of Alternatives

In order to meet the remedial goal and remedial action objectives for the site, the following remedial alternatives were developed. They include a comprehensive range of options in a manner which progressively attains RAOs with increasing complexity.

Alternative 1 – No Action
Alternative 2 – No Action with Continued Groundwater Monitoring
Alternative 3 – In Situ Treatment of Highest Concentration Portions of Plume
Alternative 4 – In Situ Treatment of Entire Plume

5.2 Description of Alternatives

Alternatives are described in accordance with DER-10, with regard to: size and configuration, time for remediation, spatial requirements, options for disposal, permitting requirements, limitations, and ecological impacts.

5.2.1 Alternative 1 - No Further Action

Under this alternative, contaminants present in groundwater would gradually attenuate over time by natural processes such as diffusion, convection resulting in dilution, biodegradation, and volatilization.

Size and Configuration

- No remedial construction would take place.

Time for Remediation

- No active remedial measures for groundwater are included. Time for remediation would be very long to meet RAOs.

Spatial Requirements

- There are no spatial requirements.

Options for Disposal

- There are no materials requiring disposal.

Permit Requirements

- No permits would be required for this alternative.

Limitations

- This alternative does not meet SCGs for groundwater in the foreseeable future.

Ecological Impacts

- This alternative is not anticipated to have any negative impacts on fish and wildlife resources.

5.2.2 Alternative 2 – No Action with Continued Groundwater Monitoring

Under this alternative, long-term groundwater monitoring would be performed to assess the degree to which the plume migrates and/or dissipates. Restrictions on groundwater use as a source of potable or process water would be enforced.

A Site Management Plan (SMP) would be developed including provisions for additional soil vapor intrusion sampling at both structures where access was previously denied should there be an ownership change or change in use. Soil vapor intrusion sampling would also be performed at any additional structures thought to be at risk based on the results of the groundwater monitoring.

Size and Configuration

- No remedial construction would take place.
- Nine existing groundwater monitoring wells shown in Figure 5-1 would be sampled annually and analyzed for VOCs.
- Additional soil vapor intrusion sampling would be performed as necessary in accordance with the SMP

Time for Remediation

- Monitoring and provisions of the SMP will be in place over the long term while natural processes continue to reduce contaminant concentrations.

Spatial Requirements

- There are no spatial requirements.

Options for Disposal

- There are minimal materials (i.e., groundwater samples) requiring disposal.

Permit Requirements

- No permits will be required for this alternative.

Limitations

- This alternative does not meet SCGs for groundwater in the foreseeable future.

Ecological Impacts

- This alternative is not anticipated to have any negative impacts on fish and wildlife resources.

5.2.3 Alternative 3 - In Situ Treatment of Highest Concentration Portions of Plume

This alternative addresses only the highest concentration portions of the plume. This portion is defined by the original source area, where PZ-1 previously had the highest PCE concentrations detected (320 µg/L in 2012, dropping to 12 µg/L by 2016), and by well MW-7 (previously the second highest detection at 280 µg/L in 2012, and in 2016 the highest concentration detected at 95 µg/L), and the zone between these two wells. This area, which cannot be precisely defined, is shown on Figure 5-2.

This alternative comprises injection of either a reduction or oxidation agent to destroy chlorinated VOC contamination. For the purposes of this FS, it is assumed that treatment would be performed with permanganate oxidation. The final choice of treatment agent would be made during the design phase of the project.

The amount of permanganate required is estimated based on the entire area of the plume shown in Figure 5-2, even though access to portions of this area are not available due to the presence of buildings. The permanganate requirements for treatment are typically determined by the natural oxidant demand (NOD) of the aquifer material. No site-specific NOD analyses were performed on soils from the site; however, typical NOD values for this type of soil are 1 milligram per kilogram (mg/kg). Based on this assumed NOD, calculations presented in Appendix C show approximately 158,000 lb of potassium permanganate would be required. Potassium permanganate is less expensive and is delivered as a solid. However, potassium permanganate needs to be mixed into solution onsite, and is limited to a maximum injection concentration of about 4%. This would require up to 474,000 gallons of 4% potassium permanganate solution to be injected. Sodium permanganate is received onsite as a concentrated liquid. Although dilution may be required prior to injection, no solid/liquid mixing is required. Additionally, sodium permanganate may be injected at concentrations up to 20%, requiring less water to be injected into the aquifer, thus reducing the extent of contaminant displacement. Sodium permanganate is selected as the oxidant for this alternative for these reasons. However, while sodium permanganate is simpler to prepare, additional safety and material compatibility issues would need to be considered in the design and implementation.

Size and Configuration

- The injection wells would be located along the accessible public rights of way. Typically this would be in sidewalks, but the injection wells may be located along the edges of the road way as necessary to avoid utilities. Although this does not provide uniform access to the plume, the quantity of permanganate injected would be sufficient to treat the NOD and contaminants throughout the whole high concentration zone. Accessing the portions of the plume further from the injection wells would be accomplished via convection and diffusion of the permanganate.
- The use of dedicated injection wells, compared to delivery via direct push, allows the opportunity to perform multiple injections without mobilizing a drill rig for each event. Assuming a 15-foot radius of influence (ROI), the injection area shown in Figure 5-2 would call for about 50 injection wells. At a 10% solution, approximately 156,000 gallons of sodium permanganate solution would be injected into the aquifer. This volume is calculated based upon and assumed natural oxidant demand of 1 g/kg, and assuming the entire thickness of the water bearing zone (from the water table to

the clay confining layer) required treatment. Both of these assumptions should be evaluated during a design phase investigation.

- Each injection point would apply reagent throughout a depth interval from about 35 to 40 feet bgs down to a depth of 60 to 70 ft bgs. However, the injection screens should not be installed throughout the entire depth, as the permanganate would then flow into the most permeable horizons, which may not contain the greatest amounts of contamination. The injection screen elevations should be selected during a design phase investigation using, for example, direct push investigations with a membrane interface probe to identify the horizons with greatest VOC contamination.
- Soil vapor monitoring points would be installed and sampled in the vicinity of the oxidant delivery due to the possibility of oxidant reactions generating heat that may accelerate volatilization.
- It is anticipated that a minimum of two injection events would be required. Half the permanganate from the stoichiometry (primarily driven by the natural oxidant demand) would be injected during each event. After the first injection, redox and color measurements would be taken weekly until the absence of purple color and lower redox potential indicate the permanganate has been consumed. At that point, a round of sampling would be performed to provide interim progress results. Unless clean up objectives are met, a second injection would then be applied.
- A two year period of monitoring is included to assess the effectiveness of remediation.
- A Site Management Plan (SMP) would be developed including provisions for additional soil vapor intrusion sampling at both structures where access was previously denied should there be an ownership change or change in use. Soil vapor intrusion sampling would also be performed at any additional structures thought to be at risk based on the results of the groundwater monitoring.

Time for Remediation

- The total time to implement this alternative would be one to two years. The longest duration components of the alternative are the installation of the injection wells and the time allowed for the permanganate to disperse and react with the contamination.

Well installation would require a few months of field work, and the duration of permanganate action (including interim sampling and data evaluation) would be approximately 3 months for each of the two injection events. Each of the two injection events could be completed in approximately four weeks for mobilization, staging of the reagent, and injection activities assuming operation of one injection well at a time. Time could be decreased by using a multi-point manifold system.

- Although the site activity could be completed in a timely fashion, the oxidation process requires months after each injection to account for diffusion of the reagent and reaction with the NOD and contaminants.

Spatial Requirements

- No permanent access to the area sidewalks would be required for this alternative. However, during injection events, parking spots and sidewalks would be occupied by the injection equipment adjacent to the wells.

- Because there is no storage area available on site, reagent and injection equipment would need to be brought to the site on a daily basis to perform the injections.

Permit Requirements

- No permits would be required for injection of treatment reagent. Injection wells incidental to aquifer remediation and experimental technologies are distinguished from hazardous waste injection wells and are designated as Class V under the Underground Injection Control (UIC) program. Class V wells covered by the Federal UIC program are authorized by rule and do not require a separate UIC permit. However, an inventory of the injection wells and proposed injection material must be provided to USEPA.

- Sidewalk opening permits would be required for installation of the injection wells.

Limitations

- The presence of the building provides limitations to this alternative. Although no wells are located within building footprints, it is inferred that the plume is located beneath these buildings based on the locations of the downgradient wells. The permeable nature of the saturated zone below this portion of the site should allow, to a certain extent, the treatment reagents to treat the contaminants in this area via diffusion and convection.

Ecological Impacts

- This alternative is not anticipated to have any negative impacts on fish and wildlife resources.

5.2.4 Alternative 4 - In Situ Treatment of Entire Plume

Alternative 4 is similar to Alternative 3, but covers a larger area.

Size and Configuration

- This alternative would be configured similarly to Alternative 3 with respect to the spacing of the injection wells, the well construction details, and with the wells installed along the rights of way (typically in the sidewalks), and soil vapor monitoring points installed and sampled in the vicinity of the oxidant delivery. However, the wells would be installed along the sidewalks over a larger area as shown on Figure 5-3. As with Alternative 3, the injection wells would be located along the accessible public rights of way. Although this does not provide uniform access to the plume, the quantity of permanganate injected would be sufficient to treat the NOD and contaminants throughout the whole high concentration zone. Accessing the portions of the plume further from the injection wells would be accomplished via convection and diffusion of the permanganate.
- Assuming a 15-foot radius of influence (ROI), the injection area shown in Figure 5-3 would call for about 125 injection wells. At a 10% solution, approximately 483,500 gallons of sodium permanganate solution would be injected into the aquifer. This volume is calculated based upon and assumed natural oxidant demand of 1 g/kg.

Time for Remediation

- The time for remediation would be similar to that described for Alternative 3. Well installation time and injection time would be approximately double because of the increase from 50 to 125 injection wells.

Spatial Requirements

- The spatial requirements would be similar to those described for Alternative 3.

Permit Requirements

- Permit requirements would be similar to those described for Alternative 3.

Limitations

- The presence of the building presents similar limitations as those described for Alternative 3.

Ecological Impacts

- This alternative is not anticipated to have any negative impacts on fish and wildlife resources.

6.0 DETAILED ANALYSIS OF ALTERNATIVES AND RECOMMENDED REMEDY

6.1 Description of Evaluation Criteria

Each of the alternatives is subjected to a detailed evaluation with respect to the criteria outlined in 6 NYCRR Part 375. A description of each of the evaluation criteria is provided below. This evaluation aids in the selection process for remedial actions in New York State.

Overall Protection of Public Health and the Environment

This criterion is an assessment of whether the alternative meets requirements that are protective of human health and the environment. The overall assessment is based on a composite of factors assessed under other evaluation criteria, particularly long-term effectiveness and permanence, short-term effectiveness, and compliance with SCGs. This evaluation focuses on how a specific alternative achieves protection over time and how site risks are reduced. The analysis includes how the source of contamination is to be eliminated, reduced, or controlled.

Compliance with Standards, Criteria, and Guidance

This criterion determines whether or not each alternative and the proposed remedial technologies comply with applicable environmental laws and SCGs pertaining to the chemicals detected in contaminated media and the location of the site.

Long-term Effectiveness and Permanence

This criterion addresses the performance of a remedial action in terms of its permanence and the quantity/nature of waste or residuals remaining at the site after implementation. An evaluation is made on the extent and effectiveness of controls required to manage residuals remaining at the site and the operation and maintenance systems necessary for the remedy to remain effective. The factors that are evaluated include permanence of the remedial alternative, magnitude of the remaining risk, adequacy and reliability of controls used to manage residual contamination.

Reduction of Toxicity, Mobility or Volume with Treatment

This criterion assesses the remedial alternative’s use of technologies that permanently and significantly reduce toxicity, mobility, or volume (TMV) of the contamination as their principal element. Preference is given to remedies that permanently and significantly reduce the toxicity, mobility, or volume of the contaminants at the site.

Short-term Effectiveness

This criterion assesses the effects of the alternative during the construction and implementation phase with respect to the effect on human health and the environment. The factors that are assessed include protection of the workers and the community during remedial activities, environmental impacts that result from remediation, and the time required until the remedial action objectives are achieved.

Implementability

This criterion addresses the technical and administrative feasibility of implementing the alternative and the availability of various services and materials required during implementation. The evaluation includes the feasibility of construction and operation, the reliability of the technology, the ease of undertaking additional remedial action, monitoring considerations, activities needed to coordinate with regulatory agencies, availability of adequate equipment, services and materials, offsite treatment, and storage and disposal services.

Land Use

This criterion addresses the current, intended, and reasonably anticipated future land use of the site and surroundings. Part 375-6 Remedial Program Soil Cleanup Objectives for unrestricted use were utilized since the site is in a mixed residential and commercial area.

Cost

Capital costs and operation, maintenance, and monitoring costs (OM&M) are estimated for each alternative and presented as present worth using a 5% discount rate for the duration of future activities.

Community and State Acceptance

Concerns of the State and the Community will be addressed separately in accordance with the public participation program developed for this site.

6.2 Alternative 1 – No Further Action

Under this alternative, contaminated groundwater would remain above SCGs. No construction would be required.

6.2.1 Overall Protection of Public Health and the Environment

This alternative is not protective of public health and the environment. Although there are no known current completed exposure pathways (existing SSD systems in area structures address the vapor intrusion pathway), contamination would remain in groundwater at concentrations that could pose a health threat in the future should site use change and/or subsurface construction activities be conducted, and some structures have not been tested due to lack of access.

6.2.2 Compliance with SCGs

This alternative does not meet groundwater SCGs.

6.2.3 Long-Term Effectiveness and Permanence

This alternative is not effective in the long term.

6.2.4 Reduction of Toxicity, Mobility and Volume with Treatment

Natural processes which are currently active in soil and groundwater would continue to reduce contaminant levels. However, the existing natural processes would not destroy the majority of the contamination within the foreseeable future.

6.2.5 Short-Term Effectiveness

As there is no construction associated with this alternative, there would be no short-term impacts to workers or the community.

6.2.6 Implementability

This alternative would be difficult to implement due to administrative issues, especially State and local approvals. The RAOs would not be met. The site would not meet the SCGs for unrestricted use, and groundwater contamination would remain above SCGs.

6.2.7 Land Use

This alternative would not allow unrestricted site use, but with the in-place SSD systems, existing uses could be continued.

6.2.8 Cost

There is no remediation cost associated with this alternative.

6.3 Alternative 2 – No Action with Continued Groundwater Monitoring

Under this alternative, contaminated groundwater would remain onsite above SCGs. Institutional controls would include long-term groundwater monitoring and during this time period, pre-existing local New York City restrictions on groundwater use as a source of potable or process water would be enforced. No construction is included.

6.3.1 Overall Protection of Public Health and the Environment

This alternative is protective of public health and the environment through enforcement of existing limitations on use of groundwater, and inspection and maintenance of existing SSD systems. Additional vapor intrusion testing may be required to ensure all structures that need SSD systems are so equipped in order to maintain effectiveness. Long-term groundwater monitoring would evaluate the effectiveness of this alternative in providing continued protection to public health and the environment.

6.3.2 Compliance with SCGs

This alternative does not meet groundwater SCGs.

6.3.3 Long-Term Effectiveness and Permanence

This alternative is not effective in meeting SCGs in the long term. Restrictions on groundwater use and continued maintenance of SSD systems would provide long term protection against contaminant exposure. Although the site would not meet the SCGs for groundwater contamination, this alternative would be effective in protecting human health as there is no use of groundwater in this area for consumption, and vapor intrusion issues are addressed, as needed, by mitigation systems.

6.3.4 Reduction of Toxicity, Mobility and Volume with Treatment

Natural processes which are currently active in groundwater would continue to reduce contaminant concentrations. However, existing natural processes will not destroy the majority of contamination within the foreseeable future.

6.3.5 Short-Term Effectiveness

As there is no construction associated with this alternative, there would be no short-term impacts to workers or the community.

6.3.6 Implementability

This alternative is implementable. A site management plan covering long term groundwater monitoring could be implemented. The local groundwater use restrictions currently exist.

6.3.7 Land Use

Due to the absence of soil contamination, no limitations in land use are anticipated.

6.3.8 Cost

Estimated capital and OM&M costs for Alternative 2 are presented in Tables 6-1 and 6-2. There are no capital costs and annual OM&M costs are $13,000; and the total present worth of Alternative 2 is $110,000 for an assumed 10 year monitoring period.

6.4 Alternative 3 - In Situ Treatment of Highest Concentration Portions of Plume

Under this alternative, permanganate would be injected into the highest concentration portions of the plume, where access is available for injection. The permanganate would react with and destroy contamination.

6.4.1 Overall Protection of Public Health and the Environment

Implementation of this alternative would be protective of public health and the environment through reducing contaminant concentrations in the groundwater. Although structures that have been tested and shown indoor air and/or subslab vapor concentrations above NYSDOH threshold criteria have been offered mitigation systems, some structures have not been sampled due to inability to obtain permission and may contain vapors above the criteria. There may be completed exposure pathways to receptors in those structures.

6.4.2 Compliance with SCGs

This alternative would contribute to meeting groundwater SCGs. If diffusion and convection prove to be effective in transporting the permanganate to the portions of the high-concentration plume inaccessible to injection wells (i.e. under the existing structures), then SCGs in this higher concentration zone would be met. However, portions of the plume outside the injection area would remain above SCGs until natural attenuation processes reduce contaminant concentrations.

6.4.3 Long-Term Effectiveness and Permanence

The chemistry of oxidation is well documented and effective in destroying chlorinated ethenes. The effectiveness of oxidation at this site will be determined primarily by the ability to adequately distribute treatment reagent and promote contact between the reagent and the full extent of contamination (in order for the oxidation reaction to take place). However, where contact takes place, the oxidation reaction permanently destroys the chlorinated ethene contamination.

Institutional controls, such as the pre-existing limitation on the use of groundwater, would restrict exposure to contamination, while remediation and natural processes reduce contaminant concentrations. Monitoring over a ten year period is included to assess the effectiveness of proposed remedial measures. Residual contamination may remain.

6.4.4 Reduction of Toxicity, Mobility and Volume with Treatment

In situ treatment included in Alternative 3 would reduce the toxicity of contaminants through degradation to innocuous compounds.

6.4.5 Short-Term Effectiveness

No permanent access to the site would be required for this alternative. However, during injection events, nearly full access to the site sidewalks would be required, although only a portion at a time.

6.4.6 Implementability

The urban nature of the site poses an obstacle to implementability. Injection wells would have to be installed in public rights of way, and a dense network of utilities makes it difficult to install wells at regular intervals required for uniform reagent distribution.

6.4.7 Land Use

Due to the absence of soil contamination, no limitations in land use are anticipated.

6.4.8 Cost

Estimated capital and OM&M costs for Alternative 3 are presented in Tables 6-1 and 6-2. The total capital cost is approximately $2,110,000; annual OM&M costs are estimated at $13,000; and the total present worth of Alternative 3 is $2,220,000 for 10 years of post-treatment monitoring.

6.5 Alternative 4 - In Situ Treatment of Entire Plume

Under this alternative, permanganate would be injected into all portions of the plume, where access is available for injection. The permanganate would react with and destroy contamination.

6.5.1 Overall Protection of Public Health and the Environment

Because there are no known existing exposure pathways, implementation of this alternative would be protective of public health and the environment through reducing contaminant concentrations in the groundwater. Although structures that have been tested and shown indoor air and/or subslab vapor concentrations above NYSDOH threshold criteria have been offered mitigation systems, some structures have not been sampled due to inability to obtain permission and may contain vapors above the criteria. There may be completed exposure pathways to receptors in those structures.

6.5.2 Compliance with SCGs

This alternative would meet groundwater SCGs, although it relies on diffusion and convection to be effective in transporting the permanganate to the portions of the plume inaccessible to injection wells (i.e. under the existing structures).

6.5.3 Long-Term Effectiveness and Permanence

The chemistry of oxidation is well documented and effective in destroying chlorinated ethenes. The effectiveness of oxidation at this site will be determined primarily by the ability to adequately distribute treatment reagent and promote contact between the reagent and the full extent of contamination (in order for the oxidation reaction to take place). However, where contact takes place, the oxidation reaction permanently destroys the chlorinated ethene contamination.

6.5.4 Reduction of Toxicity, Mobility and Volume with Treatment

In situ treatment included in Alternative 4 would reduce the toxicity of contaminants through degradation to innocuous compounds.

6.5.5 Short-Term Effectiveness

No permanent access to the site would be required for this alternative. However, during injection events, nearly full access to the site sidewalks be required, although only a portion at a time.

6.5.6 Implementability

The urban nature of the site poses an obstacle to implementability. Injection wells would have to be installed in public rights of way, and a dense network of utilities makes it difficult to install wells at regular intervals required for uniform reagent distribution.

6.5.7 Land Use

Due to the absence of soil contamination, no limitations in land use are anticipated.

6.5.8 Cost

Estimated capital and OM&M costs for Alternative 4 are presented in Tables 6-1 and 6-2. The total capital cost is approximately $5,830,000; annual OM&M costs are estimated at $13,000; and the total present worth of Alternative 3 is $5,890,000 for 5 years of post-treatment monitoring. Fewer years of monitoring are assumed due to the greater amount of treatment provided by this alternative.

6.6 Comparative Analysis of Alternatives

6.6.1 Overall Protection of Public Health and the Environment

Only the vapor intrusion exposure pathway is active at this site. This exposure pathway is effectively mitigated with installed SSD systems in all structures known to have indoor air or subslab air contamination above guidance values. However, additional structures may be subject to this exposure pathway due to plume migration or if current owners did not allow testing. Alternatives 3 and 4 would provide greater protection of human health through reducing the groundwater contaminant concentrations. Alternative 4 would be slightly more protective as it would address a greater portion of the plume.

6.6.2 Compliance with SCGs

Groundwater SCGs would eventually be met by all alternatives, although Alternatives 3 and 4, with active treatment, would accelerate the meeting of SCGs. Alternatives 1 and 2 would allow the groundwater to approach SCGs only through natural processes, and would take the longest to reduce contaminant concentrations. There appears to be only limited natural dechlorination occurring and thus SCGs could only be met through plume dispersion, which does not result in destruction of contaminants. Alternatives 3 and 4 provide active treatment to reduce the mass of contamination and thus approach or meet groundwater SCGs. Alternative 4 applies treatment over a greater area allowing for more rapid meeting of SCGs.

6.6.3 Long-Term Effectiveness and Permanence

The proposed treatment proposed for Alternatives 3 and 4 have been shown to be effective on the contaminants present at the site. Oxidation by permanganate permanently destroys the contaminants present at this site. With both these alternatives, some residual contamination may remain in low permeability zones or in portions of the plume below structures and thus inaccessible to direct reagent injection.

6.6.4 Reduction of Toxicity, Mobility and Volume with Treatment

The permanganate treatment process that would be used with Alternatives 3 and 4 provides toxicity reduction through destruction of the groundwater contaminants.

6.6.5 Short-Term Effectiveness

Alternatives 1 and 2 pose no additional impacts to workers or the community. For Alternatives 3 and 4, installation of the injection wells and the injection events pose short-term risks and disruptions to workers and the community. Alternatives 3 and 4 would include noise and traffic impacts to the community with Alternative 4 presenting the impacts over a greater area.

6.6.6 Implementability

Alternative 1 would be difficult to implement because it would not address in any way the contamination present at the site.

Alternatives 3 and 4 would be more difficult to implement as they include installation of a large quantity of injection wells within the public access (i.e., sidewalk) to a depth of up to 60 feet bgs within the remediation zone. A utility survey within the area would be required.

The total time frame for remediation for Alternatives 3 and 4 is approximately 1 to 2 years with Alterative 4 requiring several more months than Alternative 3.

6.6.7 Land Use

None of the alternatives negatively impacts land use within the remediation area.

6.6.8 Cost

Alternatives 3 and 4 have the highest capital and present worth costs. In ascending order, the present worth of the alternatives increases from 1 through 4. The total present worth of alternatives are presented on Table 6-2 using a 5 percent discount rate and 10 years of groundwater monitoring for Alternatives 2, and 3, and 5 years for Alternative 4.

6.7 Recommended Remedy

The recommended remedy is Alternative 2, No Action with Continued Groundwater Monitoring. Alternatives 3 and 4 are not selected due to implementability challenges resulting from the developed urban neighborhood. The presence of buildings limits the ability to fully treat the plume, and thus would not provide significantly greater protection than Alternative 2.

7.0 REFERENCES

New York State Department of Environmental Conservation. 2010. DER-10, Technical Guidance for Site Investigation and Remediation. May.

NYSDEC. 2006. Subpart 375-6 Remedial Program Soil Cleanup Objectives. December.

Shaw Environmental & Infrastructure Engineering of New York, P.C., Final Remedial Investigation Report for 192 Ralph Avenue Off-Site Remedial Program, Brooklyn, Kings County, NY. September, 2015.

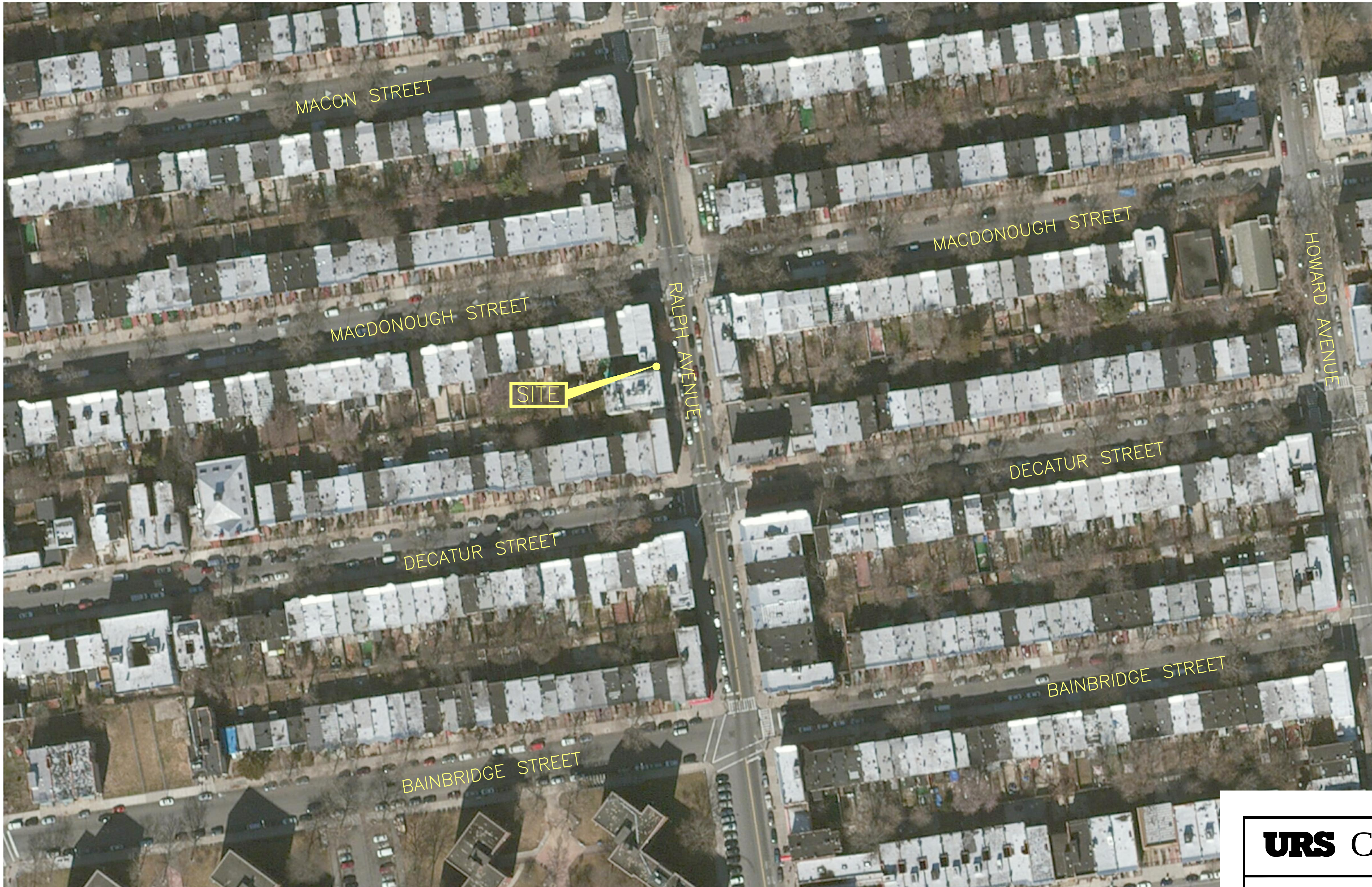
TABLES

TABLE 3-1

DEVELOPMENT OF SITE-SPECIFIC REMEDIAL ACTION OBJECTIVES

MEDIUM	REMEDIAL ACTION OBJECTIVE	RATIONALE	SITE RAO
Groundwater	Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards.	Although potable water is provided to all residents and commercial establishments in the area by New York City, installation of new water supply wells in the future may provide a complete exposure pathway.	Yes
Groundwater	Prevent contact with, or inhalation of, volatiles from contaminated groundwater.	Dermal contact with contaminated groundwater is a potential completed pathway in the event of intrusive subsurface (construction) activity at the site.	Yes
Groundwater	Restore groundwater aquifer to pre-disposal / pre-release conditions, to the extent practicable.	A plume of dissolved contamination consisting of chlorinated hydrocarbons and limited in horizontal and vertical extent is present at the site.	Yes
Groundwater	Prevent the discharge of contaminants to surface water.	The extent of dissolved phase groundwater plume is limited horizontally and vertically and does not extend to nearest surface water body.	No
Groundwater	Remove the source of ground or surface water contamination.	The original source of contamination is suspected to be at 192 Ralph Ave. However, the soil boring advanced immediately adjacent to this building did not reveal PCE contamination above the Part 375 unrestricted use criterion suggesting the release has already fully migrated from the site into the groundwater.	No
Air	Mitigate impacts to public health resulting from the potential for soil vapor intrusion into buildings.	Structure sampling has identified some structures that contained VOC vapors in or below the structure at levels that resulted in actions being taken to reduce potential exposures to contaminants through soil vapor intrusion.	Yes

FIGURES



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ENVIRONMENTAL CONSERVATION
192 RALPH AVENUE OFF-SITE PLUME TRACKDOWN

FIGURE 2-1
SITE LOCATION MAP

192 RALPH AVE
BROOKLYN, NEW YORK

File: \\URSBuffalo.us.ie.urs\Buffalo\Projects\60508882_ralphovefs\900-CAD-GIS\910-CAD\FIGURES 2-1 – 3-1.dwg
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Plotted By: rick.leckszell
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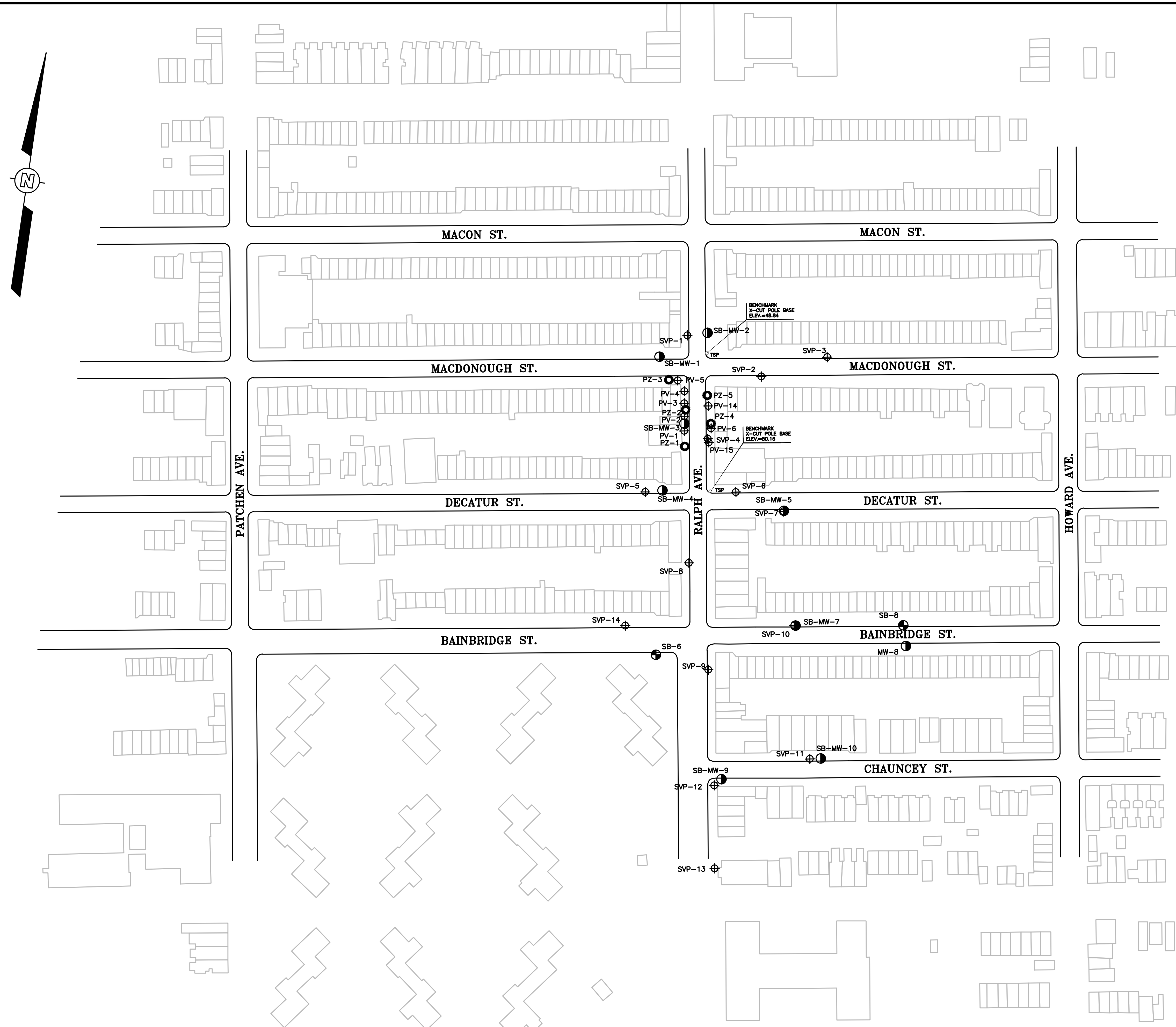

LEGEND

MW-5	MONITOR WELL
PV-5	SOIL VAPOR POINT
PZ-3	PIEZOMETER
SB-6	SOIL BORING
SVP-2	SOIL VAPOR POINT
TSP	TRAFFIC SIGNAL POLE

NOTES:
1. North orientation and coordinates are referenced to Grid North and are based on the New York State Plane Coordinate System, Long Island Zone, NAD 83 obtained from GPS observations made on February 20, 2013.
2. Vertical datum shown hereon is NAVD 88 and was obtained through GPS observations.
3. Method of data collection used was G2 – GPS Carrier Phase Kinematic Relative–Positioning Technique.
   Horizontal Accuracy: 0.03 ft. + 1 ppm rms.
   Vertical Accuracy: 0.065 ft + 1 ppm rms.
4. Buildings and streets within the immediate area of the located sample points and monitoring wells were shown using conventional survey methods. Buildings outlines and streets not in the area of these locations were delineated from digital ortho imagery taken from Bing Maps.

SCALE
0 200 400 FEET

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NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

FIGURE 2-2

SAMPLE LOCATION MAP

192 RALPH AVE

BROOKLYN, NEW YORK

File: J:\Projects\60508882_ralphavefs\900-CAD-GIS\910-CAD\CAD\FIGURES 2-1 - 3-1.dwg
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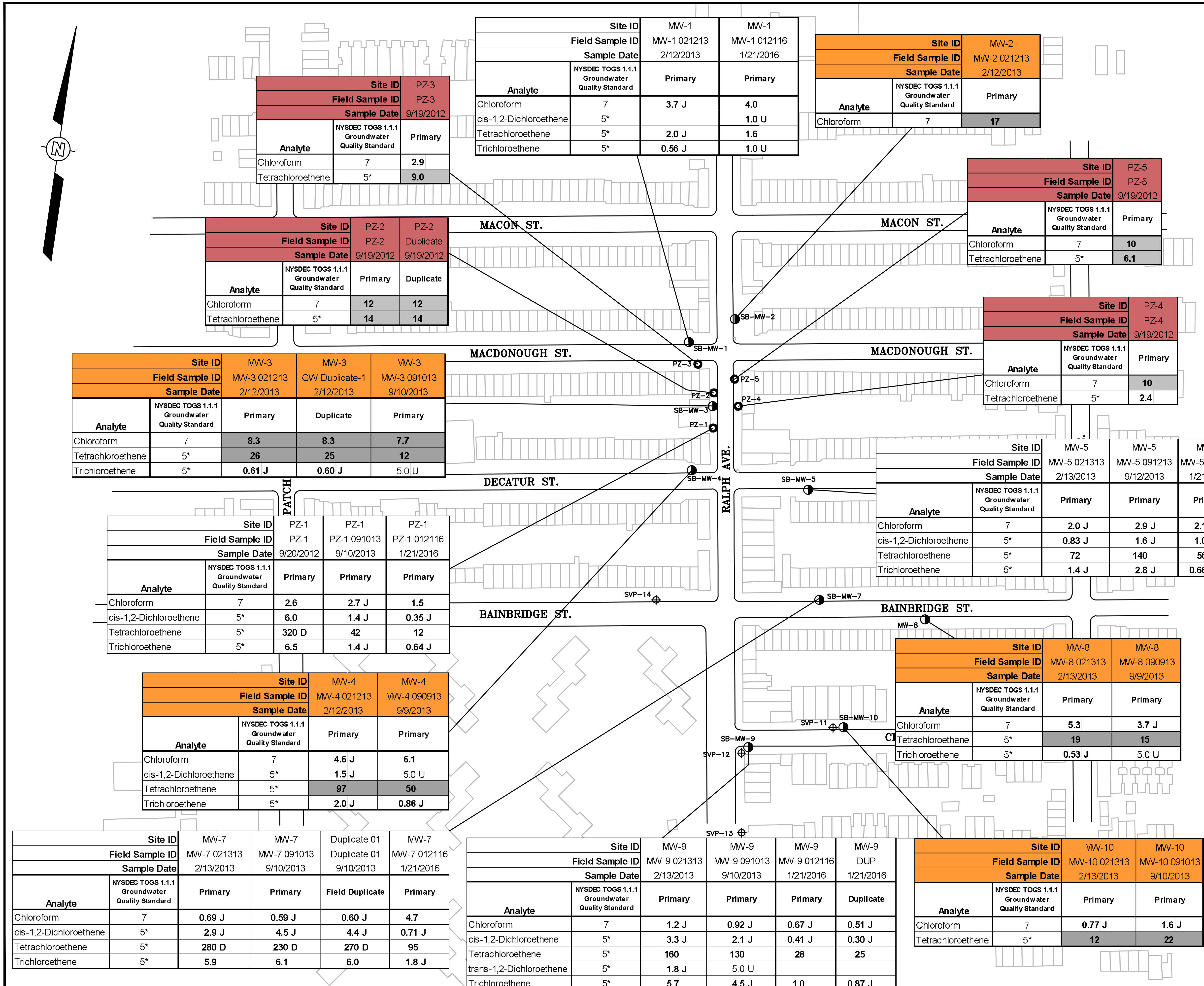

Site ID		MW-1	MW-1
Field Sample ID		MW-1 021213	MW-1 012116
Sample Date		2/12/2013	1/21/2016
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	3.7 J	4.0
cis-1,2-Dichloroethene	5*		1.0 U
Tetrachloroethene	5*	2.0 J	1.6
Trichloroethene	5*	0.56 J	1.0 U

Site ID		MW-2
Field Sample ID		MW-2 021213
Sample Date		2/12/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	17

Site ID		PZ-3
Field Sample ID		PZ-3
Sample Date		9/19/2012
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	2.9
Tetrachloroethene	5*	9.0

Site ID		PZ-5
Field Sample ID		PZ-5
Sample Date		9/19/2012
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	10
Tetrachloroethene	5*	6.1

Site ID		PZ-2	PZ-2
Field Sample ID		PZ-2	Duplicate
Sample Date		9/19/2012	9/19/2012
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Duplicate
Chloroform	7	12	12
Tetrachloroethene	5*	14	14

Site ID		PZ-4
Field Sample ID		PZ-4
Sample Date		9/19/2012
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	10
Tetrachloroethene	5*	2.4

Site ID		MW-3	MW-3	MW-3
Field Sample ID		MW-3 021213	GW Duplicate-1	MW-3 091013
Sample Date		2/12/2013	2/12/2013	9/10/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Duplicate	Primary
Chloroform	7	8.3	8.3	7.7
Tetrachloroethene	5*	26	25	12
Trichloroethene	5*	0.61 J	0.60 J	5.0 U

Site ID		MW-5	MW-5	MW-5
Field Sample ID		MW-5 021313	MW-5 091213	MW-5 012116
Sample Date		2/13/2013	9/12/2013	1/21/2016
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary	Primary
Chloroform	7	2.0 J	2.9 J	2.1
cis-1,2-Dichloroethene	5*	0.83 J	1.6 J	1.0 U
Tetrachloroethene	5*	72	140	56
Trichloroethene	5*	1.4 J	2.8 J	0.66 J

Site ID		PZ-1	PZ-1	PZ-1
Field Sample ID		PZ-1	PZ-1 091013	PZ-1 012116
Sample Date		9/20/2012	9/10/2013	1/21/2016
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary	Primary
Chloroform	7	2.6	2.7 J	1.5
cis-1,2-Dichloroethene	5*	6.0	1.4 J	0.35 J
Tetrachloroethene	5*	320 D	42	12
Trichloroethene	5*	6.5	1.4 J	0.64 J

Site ID		MW-8	MW-8
Field Sample ID		MW-8 021313	MW-8 090913
Sample Date		2/13/2013	9/9/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	5.3	3.7 J
Tetrachloroethene	5*	19	15
Trichloroethene	5*	0.53 J	5.0 U

Site ID		MW-4	MW-4
Field Sample ID		MW-4 021213	MW-4 090913
Sample Date		2/12/2013	9/9/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	4.6 J	6.1
cis-1,2-Dichloroethene	5*	1.5 J	5.0 U
Tetrachloroethene	5*	97	50
Trichloroethene	5*	2.0 J	0.86 J

Site ID		MW-7	MW-7	Duplicate 01	MW-7
Field Sample ID		MW-7 021313	MW-7 091013	Duplicate 01	MW-7 012116
Sample Date		2/13/2013	9/10/2013	9/10/2013	1/21/2016
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary	Field Duplicate	Primary
Chloroform	7	0.69 J	0.59 J	0.60 J	4.7
cis-1,2-Dichloroethene	5*	2.9 J	4.5 J	4.4 J	0.71 J
Tetrachloroethene	5*	280 D	230 D	270 D	95
Trichloroethene	5*	5.9	6.1	6.0	1.8 J

Site ID		MW-9	MW-9	MW-9	MW-9
Field Sample ID		MW-9 021313	MW-9 091013	MW-9 012116	DUP
Sample Date		2/13/2013	9/10/2013	1/21/2016	1/21/2016
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary	Primary	Duplicate
Chloroform	7	1.2 J	0.92 J	0.67 J	0.51 J
cis-1,2-Dichloroethene	5*	3.3 J	2.1 J	0.41 J	0.30 J
Tetrachloroethene	5*	160	130	28	25
trans-1,2-Dichloroethene	5*	1.8 J	5.0 U		
Trichloroethene	5*	5.7	4.5 J	1.0	0.87 J

Site ID		MW-10	MW-10
Field Sample ID		MW-10 021313	MW-10 091013
Sample Date		2/13/2013	9/10/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	0.77 J	1.6 J
Tetrachloroethene	5*	12	22

LEGEND

- MW-8 MONITOR WELL
- PZ-3 PIEZOMETER
- MONITOR WELL VOC DETECTIONS
- PIEZOMETER VOC DETECTIONS
- EXCEEDANCE

NOTES:

1. North orientation and coordinates are referenced to Grid North and are based on the New York State Plane Coordinate System, Long Island Zone, NAD 83 obtained from GPS observations made on February 20, 2013 and
2. All analytical results are in micrograms per liter (ug/L) or parts per billion (ppb).
3. "J" Qualifier designates estimated concentration below the quantitation limit. "U" Qualifier designates the compound was not detected.

SCALE

0 200 400 FEET

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NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
192 RALPH AVENUE OFF-SITE PLUME TRACKDOWN

FIGURE 2-3
GROUNDWATER VOC RESULTS

192 RALPH AVE
BROOKLYN, NEW YORK

File: J:\Projects\60508882_ralphavefs\900-CAD-GIS\910-CAD\CAD\FIGURES 2-1 - 3-1.dwg
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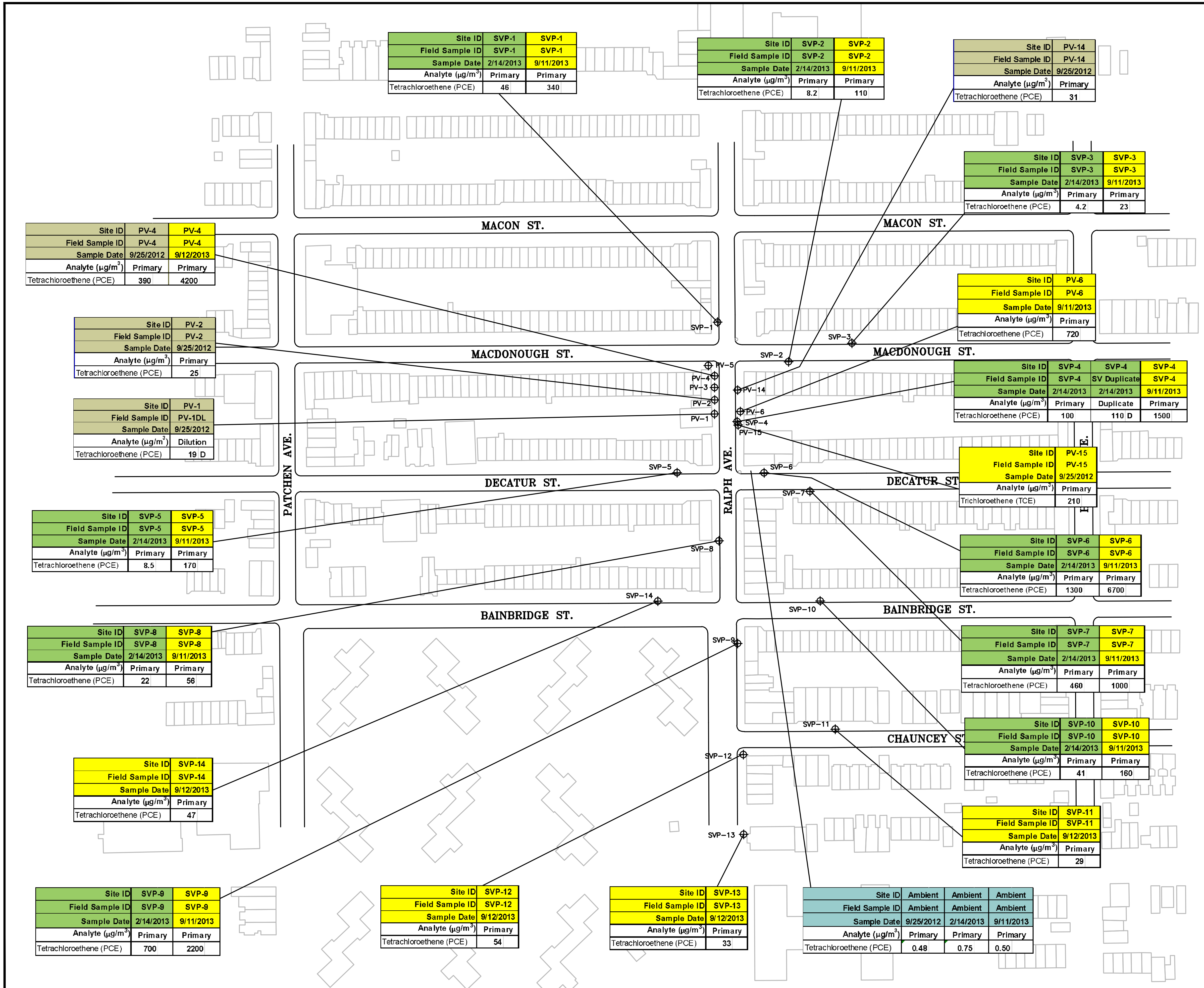

Site ID	SVP-1	SVP-1
Field Sample ID	SVP-1	SVP-1
Sample Date	2/14/2013	9/11/2013
Analyte (µg/m³)	Primary	Primary
Tetrachloroethene (PCE)	46	340

Site ID	SVP-2	SVP-2
Field Sample ID	SVP-2	SVP-2
Sample Date	2/14/2013	9/11/2013
Analyte (µg/m³)	Primary	Primary
Tetrachloroethene (PCE)	8.2	110

Site ID	PV-14
Field Sample ID	PV-14
Sample Date	9/25/2012
Analyte (µg/m³)	Primary
Tetrachloroethene (PCE)	31

Site ID	SVP-3	SVP-3
Field Sample ID	SVP-3	SVP-3
Sample Date	2/14/2013	9/11/2013
Analyte (µg/m³)	Primary	Primary
Tetrachloroethene (PCE)	4.2	23

Site ID	PV-4	PV-4
Field Sample ID	PV-4	PV-4
Sample Date	9/25/2012	9/12/2013
Analyte (µg/m³)	Primary	Primary
Tetrachloroethene (PCE)	390	4200

Site ID	PV-2
Field Sample ID	PV-2
Sample Date	9/25/2012
Analyte (µg/m³)	Primary
Tetrachloroethene (PCE)	25

Site ID	PV-6
Field Sample ID	PV-6
Sample Date	9/11/2013
Analyte (µg/m³)	Primary
Tetrachloroethene (PCE)	720

Site ID	PV-1
Field Sample ID	PV-1DL
Sample Date	9/25/2012
Analyte (µg/m³)	Dilution
Tetrachloroethene (PCE)	19 D

Site ID	SVP-4	SVP-4	SVP-4
Field Sample ID	SVP-4	SV Duplicate	SVP-4
Sample Date	2/14/2013	2/14/2013	9/11/2013
Analyte (µg/m³)	Primary	Duplicate	Primary
Tetrachloroethene (PCE)	100	110 D	1500

Site ID	PV-15
Field Sample ID	PV-15
Sample Date	9/25/2012
Analyte (µg/m³)	Primary
Trichloroethene (TCE)	210

Site ID	SVP-5	SVP-5
Field Sample ID	SVP-5	SVP-5
Sample Date	2/14/2013	9/11/2013
Analyte (µg/m³)	Primary	Primary
Tetrachloroethene (PCE)	8.5	170

Site ID	SVP-6	SVP-6
Field Sample ID	SVP-6	SVP-6
Sample Date	2/14/2013	9/11/2013
Analyte (µg/m³)	Primary	Primary
Tetrachloroethene (PCE)	1300	6700

Site ID	SVP-8	SVP-8
Field Sample ID	SVP-8	SVP-8
Sample Date	2/14/2013	9/12/2013
Analyte (µg/m³)	Primary	Primary
Tetrachloroethene (PCE)	22	56

Site ID	SVP-7	SVP-7
Field Sample ID	SVP-7	SVP-7
Sample Date	2/14/2013	9/11/2013
Analyte (µg/m³)	Primary	Primary
Tetrachloroethene (PCE)	460	1000

Site ID	SVP-10	SVP-10
Field Sample ID	SVP-10	SVP-10
Sample Date	2/14/2013	9/11/2013
Analyte (µg/m³)	Primary	Primary
Tetrachloroethene (PCE)	41	160

Site ID	SVP-14
Field Sample ID	SVP-14
Sample Date	9/12/2013
Analyte (µg/m³)	Primary
Tetrachloroethene (PCE)	47

Site ID	SVP-11
Field Sample ID	SVP-11
Sample Date	9/12/2013
Analyte (µg/m³)	Primary
Tetrachloroethene (PCE)	29

Site ID	SVP-9	SVP-9
Field Sample ID	SVP-9	SVP-9
Sample Date	2/14/2013	9/12/2013
Analyte (µg/m³)	Primary	Primary
Tetrachloroethene (PCE)	700	2200

Site ID	SVP-12
Field Sample ID	SVP-12
Sample Date	9/12/2013
Analyte (µg/m³)	Primary
Tetrachloroethene (PCE)	54

Site ID	SVP-13
Field Sample ID	SVP-13
Sample Date	9/12/2013
Analyte (µg/m³)	Primary
Tetrachloroethene (PCE)	33

Site ID	Ambient	Ambient	Ambient
Field Sample ID	Ambient	Ambient	Ambient
Sample Date	9/25/2012	2/14/2013	9/11/2013
Analyte (µg/m³)	Primary	Primary	Primary
Tetrachloroethene (PCE)	0.48	0.75	0.50

NOTES:
1. North orientation and coordinates are referenced to Grid North and are based on the New York State Plane Coordinate System, Long Island Zone, NAD 83 obtained from GPS observations made on February 20, 2013.
2. Location of ambient air sample is approximate.

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192 RALPH AVENUE OFF-SITE PLUME TRACKDOWN

FIGURE 2-4
VAPOR PHASE PCE RESULTS

192 RALPH AVE
BROOKLYN, NEW YORK

File: J:\Projects\60508882_ralphavefs\900-CAD-GIS\910-CAD\CAD\FIGURES 2-1 - 3-1.dwg
Xref:
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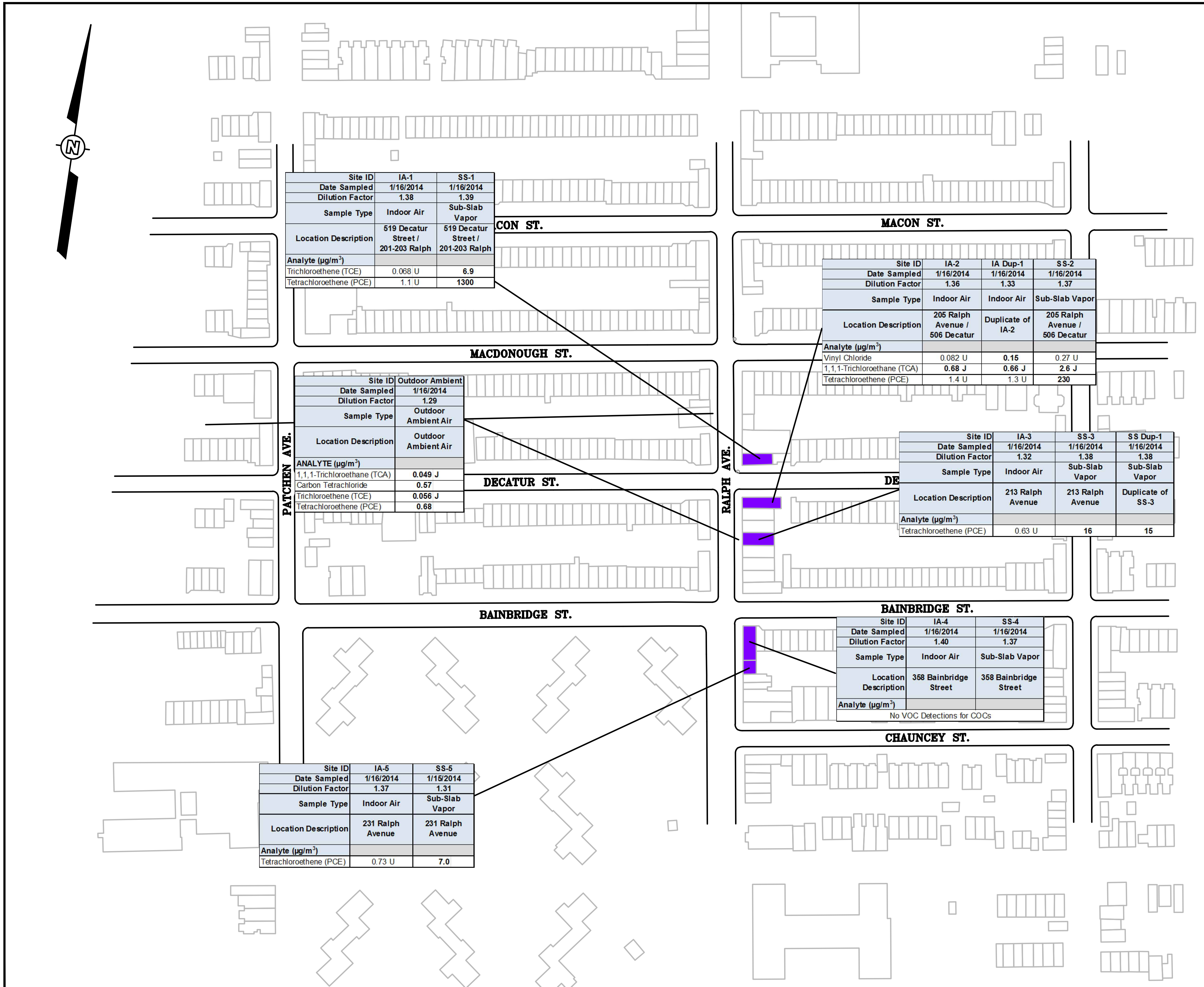
Plotted By: rick.lecksell



Site ID	IA-1	SS-1
Date Sampled	1/16/2014	1/16/2014
Dilution Factor	1.38	1.39
Sample Type	Indoor Air	Sub-Slab Vapor
Location Description	519 Decatur Street / 201-203 Ralph	519 Decatur Street / 201-203 Ralph
Analyte ($\mu g/m^3$)		
Trichloroethene (TCE)	0.068 U	**6.9**
Tetrachloroethene (PCE)	1.1 U	**1300**

Site ID	IA-2	IA Dup-1	SS-2
Date Sampled	1/16/2014	1/16/2014	1/16/2014
Dilution Factor	1.36	1.33	1.37
Sample Type	Indoor Air	Indoor Air	Sub-Slab Vapor
Location Description	205 Ralph Avenue / 506 Decatur	Duplicate of IA-2	205 Ralph Avenue / 506 Decatur
Analyte ($\mu g/m^3$)			
Vinyl Chloride	0.082 U	**0.15**	0.27 U
1,1,1-Trichloroethane (TCA)	**0.68 J**	**0.66 J**	**2.6 J**
Tetrachloroethene (PCE)	1.4 U	1.3 U	**230**

Site ID	Outdoor Ambient
Date Sampled	1/16/2014
Dilution Factor	1.29
Sample Type	Outdoor Ambient Air
Location Description	Outdoor Ambient Air
ANALYTE ($\mu g/m^3$)	
1,1,1-Trichloroethane (TCA)	**0.049 J**
Carbon Tetrachloride	**0.57**
Trichloroethene (TCE)	**0.056 J**
Tetrachloroethene (PCE)	**0.68**

Site ID	IA-3	SS-3	SS Dup-1
Date Sampled	1/16/2014	1/16/2014	1/16/2014
Dilution Factor	1.32	1.38	1.38
Sample Type	Indoor Air	Sub-Slab Vapor	Sub-Slab Vapor
Location Description	213 Ralph Avenue	213 Ralph Avenue	Duplicate of SS-3
Analyte ($\mu g/m^3$)			
Tetrachloroethene (PCE)	0.63 U	**16**	**15**

Site ID	IA-4	SS-4
Date Sampled	1/16/2014	1/16/2014
Dilution Factor	1.40	1.37
Sample Type	Indoor Air	Sub-Slab Vapor
Location Description	358 Bainbridge Street	358 Bainbridge Street
Analyte ($\mu g/m^3$)		
No VOC Detections for COCs		

Site ID	IA-5	SS-5
Date Sampled	1/16/2014	1/15/2014
Dilution Factor	1.37	1.31
Sample Type	Indoor Air	Sub-Slab Vapor
Location Description	231 Ralph Avenue	231 Ralph Avenue
Analyte ($\mu g/m^3$)		
Tetrachloroethene (PCE)	0.73 U	**7.0**

LEGEND

LOCATION OF INDOOR AIR AND SUB-SLAB SAMPLE

NOTES:

1. North orientation and coordinates are referenced to Grid North and are based on the New York State Plane Coordinate System, Long Island Zone, NAD 83 obtained from GPS observations made on February 20, 2013.
2. Analytical Notes:
   - Analysis was performed using USEPA TO-15
   - Concentration shown in microgram per cubic meter (ug/m^3)
   - All sub-slab samples were taken approximately 6" below floor surface
   - Bold – Indicates detected analyte
   - U – Indicates the analyte was analyzed for but not detected
   - J – Estimated value due to either being a Tentatively Identified Compound, or that the concentration is between the MRL and the MDL
3. Location of ambient air sample is approximate.
4. Contaminants of Concern (COCs) are: Carbon Tetrachloride, 1,1-Dichloroethene (1,1-DCE), 1,2-Dichloroethene (1,2-DCE), Tetrachloroethene (PCE), Trichloroethene (TCE) and Vinyl Chloride.

SCALE

0 200 400 FEET

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NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
192 RALPH AVENUE OFF-SITE PLUME TRACKDOWN

FIGURE 2-5
INDOOR AIR/SUB-SLAB SAMPLING

192 RALPH AVE
BROOKLYN, NEW YORK

File: J:\Projects\60508882_ralphavefs\900-CAD-GIS\910-CAD\CAD\FIGURES 2-1 – 3-1.dwg
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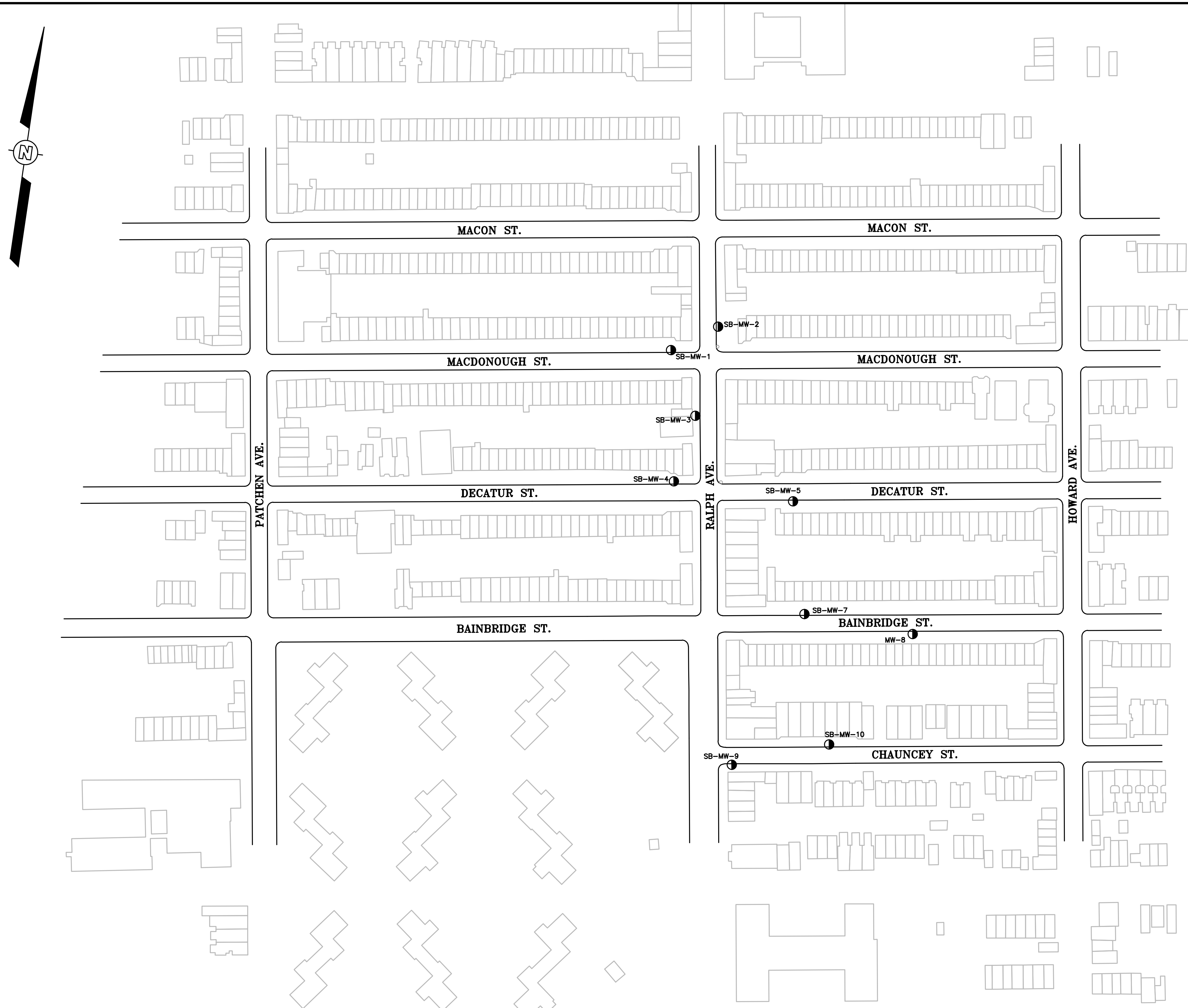

LEGEND

MW-5 MONITOR WELL TO BE SAMPLED

NOTE:
1. North orientation and coordinates are referenced to Grid North and are based on the New York State Plane Coordinate System, Long Island Zone, NAD 83 obtained from GPS observations made on February 20, 2013.

SCALE

0 200 400 FEET

URS Corporation

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
192 RALPH AVENUE OFF-SITE PLUME TRACKDOWN

FIGURE 5-1
ALTERNATIVE 2 MONITORING WELLS TO BE SAMPLED
192 RALPH AVE
BROOKLYN, NEW YORK

File: J:\Projects\60508882_ralphavefs\900-CAD-GIS\910-CAD\CAD\FIGURE 5-1.dwg
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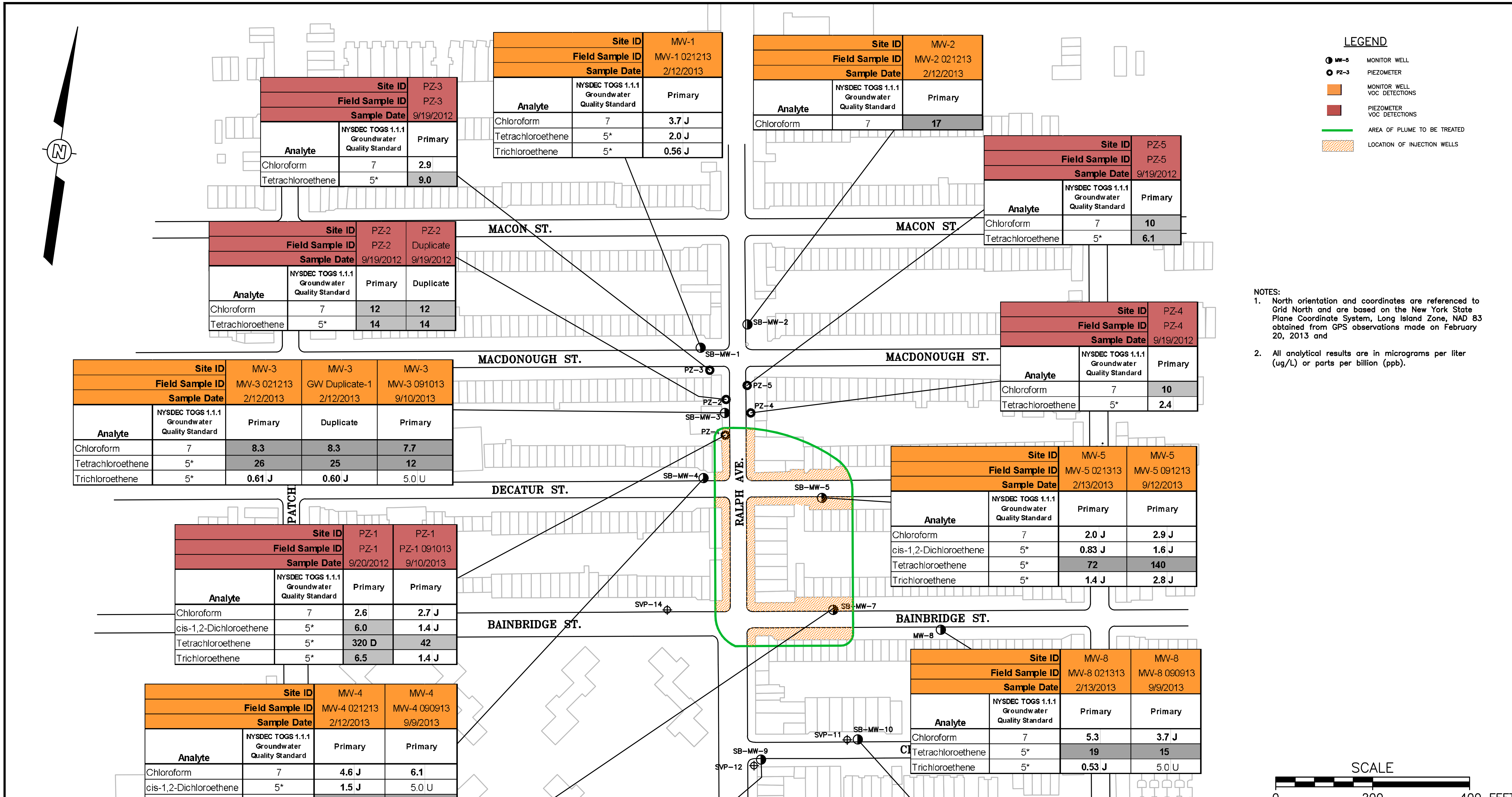

Site ID		PZ-3
Field Sample ID		PZ-3
Sample Date		9/19/2012
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	2.9
Tetrachloroethene	5*	9.0

Site ID		MW-1
Field Sample ID		MW-1 021213
Sample Date		2/12/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	3.7 J
Tetrachloroethene	5*	2.0 J
Trichloroethene	5*	0.56 J

Site ID		MW-2
Field Sample ID		MW-2 021213
Sample Date		2/12/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	17

Site ID		PZ-5
Field Sample ID		PZ-5
Sample Date		9/19/2012
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	10
Tetrachloroethene	5*	6.1

Site ID		PZ-2	PZ-2
Field Sample ID		PZ-2	Duplicate
Sample Date		9/19/2012	9/19/2012
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Duplicate
Chloroform	7	12	12
Tetrachloroethene	5*	14	14

Site ID		PZ-4
Field Sample ID		PZ-4
Sample Date		9/19/2012
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	10
Tetrachloroethene	5*	2.4

Site ID		MW-3	MW-3	MW-3
Field Sample ID		MW-3 021213	GW Duplicate-1	MW-3 091013
Sample Date		2/12/2013	2/12/2013	9/10/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Duplicate	Primary
Chloroform	7	8.3	8.3	7.7
Tetrachloroethene	5*	26	25	12
Trichloroethene	5*	0.61 J	0.60 J	5.0 U

Site ID		MW-5	MW-5
Field Sample ID		MW-5 021313	MW-5 091213
Sample Date		2/13/2013	9/12/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	2.0 J	2.9 J
cis-1,2-Dichloroethene	5*	0.83 J	1.6 J
Tetrachloroethene	5*	72	140
Trichloroethene	5*	1.4 J	2.8 J

Site ID		PZ-1	PZ-1
Field Sample ID		PZ-1	PZ-1 091013
Sample Date		9/20/2012	9/10/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	2.6	2.7 J
cis-1,2-Dichloroethene	5*	6.0	1.4 J
Tetrachloroethene	5*	320 D	42
Trichloroethene	5*	6.5	1.4 J

Site ID		MW-8	MW-8
Field Sample ID		MW-8 021313	MW-8 090913
Sample Date		2/13/2013	9/9/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	5.3	3.7 J
Tetrachloroethene	5*	19	15
Trichloroethene	5*	0.53 J	5.0 U

Site ID		MW-4	MW-4
Field Sample ID		MW-4 021213	MW-4 090913
Sample Date		2/12/2013	9/9/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	4.6 J	6.1
cis-1,2-Dichloroethene	5*	1.5 J	5.0 U
Tetrachloroethene	5*	97	50
Trichloroethene	5*	2.0 J	0.86 J

Site ID		MW-7	MW-7	Duplicate 01
Field Sample ID		MW-7 021313	MW-7 091013	Duplicate 01
Sample Date		2/13/2013	9/10/2013	9/10/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary	Field Duplicate
Chloroform	7	0.69 J	0.59 J	0.60 J
cis-1,2-Dichloroethene	5*	2.9 J	4.5 J	4.4 J
Tetrachloroethene	5*	280 D	230 D	270 D
Trichloroethene	5*	5.9	6.1	6.0

Site ID		MW-9	MW-9
Field Sample ID		MW-9 021313	MW-9 091013
Sample Date		2/13/2013	9/10/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	1.2 J	0.92 J
cis-1,2-Dichloroethene	5*	3.3 J	2.1 J
Tetrachloroethene	5*	160	130
trans-1,2-Dichloroethene	5*	1.8 J	5.0 U
Trichloroethene	5*	5.7	4.5 J

Site ID		MW-10	MW-10
Field Sample ID		MW-10 021313	MW-10 091013
Sample Date		2/13/2013	9/10/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	0.77 J	1.6 J
Tetrachloroethene	5*	12	22

NOTES:

1. North orientation and coordinates are referenced to Grid North and are based on the New York State Plane Coordinate System, Long Island Zone, NAD 83 obtained from GPS observations made on February 20, 2013 and
2. All analytical results are in micrograms per liter (ug/L) or parts per billion (ppb).

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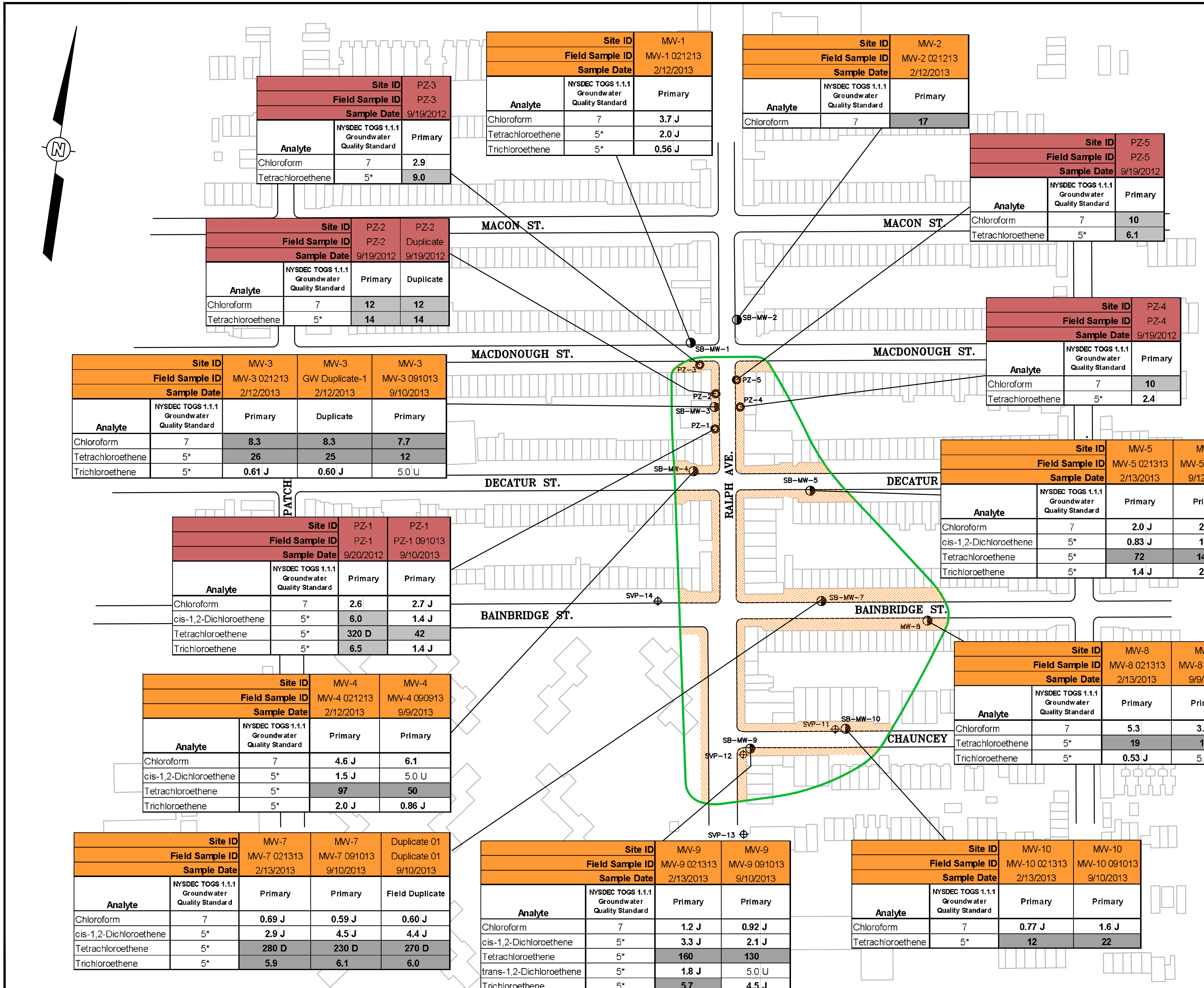
192 RALPH AVENUE OFF-SITE PLUME TRACKDOWN

FIGURE 5-2
ALTERNATIVE 3 TREATMENT LOCATION

192 RALPH AVE
BROOKLYN, NEW YORK

File: J:\Projects\60508882_ralphavefs\900-CAD-GIS\910-CAD\CAD\FIGURE 5-2.dwg
Plot Date/Time: Jun 06, 2017 - 11:59am
Plotted By: rick.lecksell
Xref:
Image: 192 RALPH AVE.jpg



Site ID		PZ-3
Field Sample ID		PZ-3
Sample Date		9/19/2012
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	2.9
Tetrachloroethene	5*	9.0

Site ID		MW-1
Field Sample ID		MW-1 021213
Sample Date		2/12/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	3.7 J
Tetrachloroethene	5*	2.0 J
Trichloroethene	5*	0.56 J

Site ID		MW-2
Field Sample ID		MW-2 021213
Sample Date		2/12/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	17

Site ID		PZ-5
Field Sample ID		PZ-5
Sample Date		9/19/2012
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	10
Tetrachloroethene	5*	6.1

Site ID		PZ-2	PZ-2
Field Sample ID		PZ-2	Duplicate
Sample Date		9/19/2012	9/19/2012
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Duplicate
Chloroform	7	12	12
Tetrachloroethene	5*	14	14

Site ID		PZ-4
Field Sample ID		PZ-4
Sample Date		9/19/2012
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	10
Tetrachloroethene	5*	2.4

Site ID		MW-3	MW-3	MW-3
Field Sample ID		MW-3 021213	GW Duplicate-1	MW-3 091013
Sample Date		2/12/2013	2/12/2013	9/10/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Duplicate	Primary
Chloroform	7	8.3	8.3	7.7
Tetrachloroethene	5*	26	25	12
Trichloroethene	5*	0.61 J	0.60 J	5.0 U

Site ID		MW-5	MW-5
Field Sample ID		MW-5 021313	MW-5 091213
Sample Date		2/13/2013	9/12/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	2.0 J	2.9 J
cis-1,2-Dichloroethene	5*	0.83 J	1.6 J
Tetrachloroethene	5*	72	140
Trichloroethene	5*	1.4 J	2.8 J

Site ID		PZ-1	PZ-1
Field Sample ID		PZ-1	PZ-1 091013
Sample Date		9/20/2012	9/10/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	2.6	2.7 J
cis-1,2-Dichloroethene	5*	6.0	1.4 J
Tetrachloroethene	5*	320 D	42
Trichloroethene	5*	6.5	1.4 J

Site ID		MW-8	MW-8
Field Sample ID		MW-8 021313	MW-8 090913
Sample Date		2/13/2013	9/9/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	5.3	3.7 J
Tetrachloroethene	5*	19	15
Trichloroethene	5*	0.53 J	5.0 U

Site ID		MW-4	MW-4
Field Sample ID		MW-4 021213	MW-4 090913
Sample Date		2/12/2013	9/9/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	4.6 J	6.1
cis-1,2-Dichloroethene	5*	1.5 J	5.0 U
Tetrachloroethene	5*	97	50
Trichloroethene	5*	2.0 J	0.86 J

Site ID		MW-7	MW-7	Duplicate 01
Field Sample ID		MW-7 021313	MW-7 091013	Duplicate 01
Sample Date		2/13/2013	9/10/2013	9/10/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary	Field Duplicate
Chloroform	7	0.69 J	0.59 J	0.60 J
cis-1,2-Dichloroethene	5*	2.9 J	4.5 J	4.4 J
Tetrachloroethene	5*	280 D	230 D	270 D
Trichloroethene	5*	5.9	6.1	6.0

Site ID		MW-9	MW-9
Field Sample ID		MW-9 021313	MW-9 091013
Sample Date		2/13/2013	9/10/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	1.2 J	0.92 J
cis-1,2-Dichloroethene	5*	3.3 J	2.1 J
Tetrachloroethene	5*	160	130
trans-1,2-Dichloroethene	5*	1.8 J	5.0 U
Trichloroethene	5*	5.7	4.5 J

Site ID		MW-10	MW-10
Field Sample ID		MW-10 021313	MW-10 091013
Sample Date		2/13/2013	9/10/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	0.77 J	1.6 J
Tetrachloroethene	5*	12	22

LEGEND

- MW-5 MONITOR WELL
- PZ-3 PIEZOMETER
- MONITOR WELL VOC DETECTIONS
- PIEZOMETER VOC DETECTIONS
- AREA OF PLUME TO BE TREATED
- LOCATION OF INJECTION WELLS

NOTES:

1. North orientation and coordinates are referenced to Grid North and are based on the New York State Plane Coordinate System, Long Island Zone, NAD 83 obtained from GPS observations made on February 20, 2013 and
2. All analytical results are in micrograms per liter (ug/L) or parts per billion (ppb).

SCALE

0 200 400 FEET

URS Corporation

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
192 RALPH AVENUE OFF-SITE PLUME TRACKDOWN

FIGURE 5-3
ALTERNATIVE 4 TREATMENT LOCATION

192 RALPH AVE
BROOKLYN, NEW YORK

File: J:\Projects\60508882_ralphavefs\900-CAD-GIS\910-CAD\CAD\FIGURE 5-3.dwg
Plot Date/Time: Jun 06, 2017 - 11:56am
Plotted By: rick.lecksell
Xref:
Image: 192 RALPH AVE.jpg

APPENDIX A

PERMANGANATE INJECTION CALCULATIONS

1.0 Purpose

This calculation estimates the amount of potassium permanganate or sodium permanganate to inject at a chlorinated hydrocarbon plume in groundwater at the 192 Ralph Avenue site in Brooklyn, New York under Alternative 3.

2.0 Data and Assumptions

2.1 Data

- Target compounds are Tetrachloroethene, Trichloroethene, Chloroform, and cis-1,2-Dichloroethene. Contaminant concentrations are assumed to be 0.1 mg/L based on typical concentrations detected on site (Ref. 1). It is noted that the oxidant demand is primarily driven by the natural demand, no the contaminants' demand.

- The aquifer thickness at the site is 30 feet (Ref 1).

2.2 Assumptions

- The treatment would be conducted within an area of approximately 2.75 acres, or 119,790 ft^2. The reagent would be injected using direct push injection points, at depths approximately 35 feet bgs to 60 feet bgs to treat the full thickness of the aquifer.

- The total and effective porosity of the soil is estimated to be approximately 30%.

- Natural Oxidant Demand is assumed to be 1 mg/kg.

3.0 Calculations

The amount of potassium permanganate or sodium permanganate to be injected in the treatment area is determined using the estimated mass of dissolved levels of contamination and, more importantly, the assumed oxidant demand.

The amount of permanganate is calculated using an excel spreadsheet provided by Carus Remediation Technologies (CRT), a supplier of permanganate. The length and width of the treatment area were set to result in a total area of 119,790 ft^2 which is the area of treatment shown on Figure 1, as calculated in CAD. The thickness of the treatment area is the aquifer thickness of 30 feet. A typical value of 30% was assumed for the porosity of the soil. A conservative estimation of the average contaminant concentration of 0.1 ppm was used based on the RI results. Permanganate natural oxidant demand (PNOD) was assumed to be 1 g/kg. Default values set by CRT were used for effective PNOD (20%), confidence factor (2), and injection concentration (10%). The CRT spreadsheet requires entering the stoichiometric demand for oxidation using potassium permanganate as the oxidant. An average stoichiometric demand of 1.27 lb/lb was calculated based on the following chemical reaction:

$$4KMnO_4 + 3C_2Cl_4 + 4H_2O \rightarrow 6CO_2 + 4MnO_2 + 4K^+ + 8H^+ + 12Cl^-$$

$$4\,mol \times 158\,g/mol\,KMnO_4 = 632\ g\ KMnO_4$$

$$3\,mol \times 165.8\,g/mol\,C_2Cl_4 = 497\ g\ C_2Cl_4$$

$$\frac{568\ g\ KMnO_4}{497\ g\ C_2Cl_4} = 1.27\,g/g = 1.27\,lb/lb$$

The calculation estimates that about 158,140 pounds of (solid) potassium permanganate or 355,024 pounds of 40% solution of sodium permanganate would be required.

Sodium permanganate reagent is supplied at a concentration of 40%; however, the lower concentration of 10% helps drive the reagent further into the aquifer because a larger volume is injected. An estimated 155,890 gallons of 10% solution would be required.

4.0 References

1. Shaw Environmental & Infrastructure Engineering of New York, P.C. 2005. *Final Remedial Investigation Report, 192 Ralph Avenue Off-Site Remedial Program, Brooklyn, New York*. Latham, New York.

Calculations

CRT

Carus Remediation Technologies

RemOx® S and RemOx® L
ISCO Reagents
Estimation Spreadsheet

Input data into box with black font

Site Name: 192 Ralph Avenue - Alternative 3

Date: 5/17/2017

	Estimates	Units
Treatment Area Volume		
Length	**363**	ft
Width	**330**	ft
Area	119,790	sq ft
Thickness	**30**	ft
Total Volume	133,100	cu yd
Soil Characteristics/Analysis		
Porosity	**30**	%
Total Plume Pore Volume	8,064,822	gal
Avg Contaminant Conc	**0.1**	ppm
Mass of Contaminant	6.73	lb
PNOD	**1**	g/kg
Effective PNOD	**20**	%
Effective PNOD Calculated	0.200	
PNOD Oxidant Demand	79,061.40	lb
Avg Stoichiometric Demand	**1.27**	lb/lb
Contaminant Oxidant Demand	8.55	lb
Theoretical Oxidant Demand	79,069.95	lb
Confidence Factor	**2**	
Calculated Oxidant Demand	158,139.90	

	Estimates	Units
Injection Volume for RemOx S		
Injection Concentration	**1.0%**	%
Total Volume of Injection Fluid	1,896,162	gal
Pore Volume Replaced	23.51	%
Amount of RemOx S Estimated:	**158,140**	**pounds**
Injection Volume for RemOx L		
Injection Concentration	**10.0%**	%
Calculated Specific Gravity	1.09	g/ml
Total Volume of Injection Fluid	155,890	gal
Pore Volume Replaced	1.93	%
Amount of RemOx L Estimated:	**355,024**	**pounds**
	31,061	**gallons**

Reference 1

Shaw Environmental & Infrastructure Engineering of New York, P.C.
13 British American Boulevard
Latham, NY 12110-1405
Tel: +1 518 783 1996
Fax: +1 518 783 8397
www.CBI.com

FINAL REMEDIAL INVESTIGATION REPORT

192 Ralph Avenue Off-Site Remedial Program
Brooklyn, Kings County, NY
Site Number 224042
Contract Work Authorization Number: D006132-28

Shaw Project No.: 134685.28

September 2015

Prepared for:

Robert Filkins
New York State Department of Environmental Conservation
Division of Environmental Remediation
Bureau of Program Management, Room 1224
625 Broadway, Albany, NY 12233-7012

Submitted by:

Shaw Environmental & Infrastructure Engineering of New York, P.C.,
13 British American Boulevard
Latham, New York, 12110

1.0 INTRODUCTION

Shaw Environmental & Infrastructure Engineering of New York, P.C. (Shaw) has prepared this Remedial Investigation (RI) Report summarizing collection and analysis of soil, groundwater, soil vapor and indoor air media for volatile organic compounds (VOCs) at the 192 Ralph Avenue Off-site Remedial Program (Site Number 224042) site located in Brooklyn, Kings County, New York (Site) (**Figure 1**). The primary purpose of the RI was to determine the extent of off-site impacts from contamination prior to and after startup of the soil vapor extraction (SVE) system that was installed at 192 Ralph Avenue to mitigate air quality. The scope of work discussed herein was developed in accordance with Work Assignment (WA) D006132-28 provided to Shaw on April 12, 2012, various discussions with the NYSDEC, the June 28, 2012 approved work plan (i.e. executive summary) and the February 4, 2013 amended work plan (i.e. Amendment 1)

1.1 Description and Location

Site Description

The Site is located in the Bedford-Stuyvesant section of Brooklyn, NY along Ralph Avenue between the main thoroughfares of Macon Street to the north, Marion Street to the south, Patchen Avenue to the west and Howard Avenue to the east. The off-site area of investigation is comprised of a mixture of residential and commercial properties.

Site Geology

Located in the Atlantic Coastal Plain Physiographic Province, the Pre-Cambrian Age metamorphic bedrock is believed to be over 200-feet below ground surface (bgs) at the Site. The soils at the Site have been classified as urban fill, consisting of construction debris, rock, and ash. The urban fill reaches approximately 7-feet bgs, underlain by glacial deposits consisting primarily of silt, sand and gravel. Groundwater is present in the fill and glacial deposits, occurring at depths of approximately 9-feet to 15-feet bgs. Predominant regional groundwater flow direction is toward the north-northwest, with the deep groundwater flowing north.

The geology of the Site consists of outwash sand and gravel deposits. Highly permeable fine to medium sands with some gravel appear above a confining layer of silty clay about 60 to 70-feet below ground surface (bgs). Localized groundwater flows south-southeast and is encountered 35 to 40-feet bgs.

relocated four feet south. This point was relocated for a third time directly across Decatur Street to the north where it was successfully advanced to 50-ft bgs. At SB-6, refusal was encountered once at 15-ft bgs, but the boring was successfully advanced after moving the point three feet to the west. Drill logs, which provide a more detailed account soil types and other observations, have been included as **Appendix G**.

3.2 Groundwater Sampling

Three separate groundwater sampling events were conducted at the Site. During the first event (October 2012), groundwater samples were collected from five existing piezometers. In February 2013, Shaw collected samples from the nine newly installed monitoring wells (MW-1 through MW-5 and MW-7 through MW-10. Lastly, samples were collected from monitoring wells MW-3, MW-4, MW-5, MW-7, MW-8, MW-9, and MW-10 and piezometer PZ-1 in September 2013. All samples were analyzed by Spectrum for VOCs by USEPA Method 8260B. The analytical results are summarized and compared to NYSDEC New York State Groundwater Quality Standard (NYSGWQS) as defined in the Technical and Operational Guidance Series (TOGS) 1.1.1 for VOCs on **Table 2**, and shown graphically on **Figure 4**. The complete analytical data package is included in **Appendix D**.

3.2.1 Phase I - September 2012

Several analytes were detected at concentrations exceeding NYSGWQS including chloroform, cis-1,2-dichloroethene, PCE, and TCE. There were several other compounds for which the laboratory result was reported as "non-detect", but the reporting limit exceeded groundwater quality standards. Detection ranges (minimum-maximum) in micrograms per liter (µg/L) or ppb for these compounds are summarized as follows:

- Chloroform - 2.6 µg/L to 12 µg/L at PZ-2;
- cis-1,2-Dichloroethene – Non-detect to 6.0 µg/L at PZ-1;
- PCE – 2.4 µg/L to 320D µg/L at PZ-1DL; and
- TCE – Non-detect to 6.5 µg/L at PZ-1

3.2.2 Phase II – February 2013

Analytes detected at concentrations exceeding NYSGWQS included chloroform, PCE, and TCE. There were several other compounds for which the laboratory result was reported as "non-detect", but the reporting limit exceeded groundwater quality standards. Detection ranges (minimum-maximum) in µg/L or ppb for these compounds are summarized as follows:

- Chloroform – 0.69 µg/L at MW-7 to 17 µg/L at MW-2;
- cis-1,2-Dichloroethene – Non-detect to 3.3J µg/L at MW-9;
- PCE – Non-detect to 280D µg/L at MW-7; and
- TCE – Non-detect to 5.9 µg/L at MW-7

3.2.3 Phase II – September 2013

Analytes detected at concentrations exceeding NYSGWQS included chloroform, PCE, and TCE. There were several other compounds for which the laboratory result was reported as "non-detect", but the reporting limit exceeded groundwater quality standards. Detection ranges (minimum-maximum) in µg/L or ppb for these compounds are summarized as follows:

- Chloroform – 0.59 µg/L at MW-7 to 7.7 µg/L at MW-3;
- cis-1,2-Dichloroethene – Non-detect to 4.5J µg/L at MW-7;
- PCE – 12 µg/L at MW-3 to 230D µg/L at MW-7; and,
- TCE – Non-detect to 6.1 µg/L at MW-7

3.2.4 Site Hydrogeology

Due to a low groundwater gradient a contour map could not be produced from the gauging results obtained during the February 2013 visit. Specifically, the change in water table elevation across the area is 0.56 feet; this flat elevation, combined with the relatively small size of the Site, topography and paving of the Site all combine to make the development of meaningful groundwater contours problematic. The data shows a groundwater flow direction toward the southeast which is generally consistent with historic gauging data.

3.3 Vapor Phase Sampling Results

The analytical results presented in micrograms per cubic meter ($\mu g/m^3$) for the soil vapor and ambient air samples are summarized on **Table 3**; complete analytical data package are included as **Appendix E**. Compounds detected as part of the air sampling are also presented on **Figure 5**.

Table 2
Groundwater Analytical Results
VOCs by Method 8260
192 Ralph Avenue Off-Site Plume Trackdown
September 2012, February 2013, and September 2013

Site ID		PZ-1	PZ-1	PZ-2	PZ-2	PZ-3	PZ-4	PZ-5	PZ-5		PZ-5	
Field Sample ID		PZ-1	PZ-1 091013	PZ-2	Duplicate	PZ-3	PZ-4	PZ-5	MS-PZ-5		MSD-PZ-5	
Sample Date		9/20/2012	9/10/2013	9/19/2012	9/19/2012	9/19/2012	9/19/2012	9/19/2012	9/19/2012		9/19/2012	
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary	Primary	Duplicate	Primary	Primary	Primary	Matrix Spike		Matrix Spike Duplicate	
									% Rec.	QC lim.	% Rec.	QC lim.
1,1,1-Trichloroethane	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	85	65-130	102	65-130
1,1,2,2-Tetrachloroethane	5*	1.0 UJ	5.0 U	1.0 UJ	1.0 UJ	1.0 UJ	1.0 UJ	1.0 UJ	95	65-130	99	65-130
1,1,2-Trichloro-1,2,2-trifluoroethane	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	84	70-130	105	70-130
1,1,2-Trichloroethane	1	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	93	75-125	88	75-125
1,1-Dichloroethane	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	85	70-135	97	70-135
1,1-Dichloroethene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	84	70-130	105	70-130
1,2,3-Trichlorobenzene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	76	55-140	91	55-140
1,2,3-Trichloropropane	0.04	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
1,2,4-Trichlorobenzene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	78	65-135	95	65-135
1,2,4-Trimethylbenzene	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
1,2-Dibromo-3-chloropropane	0.04	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	91	50-130	90	50-130
1,2-Dibromoethane	0.0006	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	95	80-120	99	80-120
1,2-Dichlorobenzene	3	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	84	70-120	102	70-120
1,2-Dichloroethane	0.6	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	89	70-130	103	70-130
1,2-Dichloropropane	1	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	87	75-125	101	75-125
1,3,5-Trimethylbenzene	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
1,3-Dichlorobenzene	3	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	81	75-125	97	75-125
1,3-Dichloropropane	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
1,4-Dichlorobenzene	3	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	82	75-125	96	75-125
1,4-Dioxane	NGV	100 U	100 U	100 U	100 UJ	100 U	100 U	100 U	52 ^	70-130	94	70-130
2-Butanone	50	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	88	30-150	95	30-150
4-Isopropyltoluene	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
2-Hexanone	50	5.0 U	NA	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	94	55-130	90	55-130
4-Methyl-2-pentanone	NGV	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	93	60-135	91	60-135
Acetone	50	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	78	40-140	67	40-140
Benzene	1	0.70 U	5.0 U	0.70 U	0.70 U	0.70 U	0.70 U	0.70 U	85	80-120	102	80-120
Bromochloromethane	5*	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	92	65-130	103	65-130
Bromodichloromethane	50	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	88	75-120	99	75-120
Bromoform	50	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	90	70-130	104	70-130
Bromomethane	5*	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	77	30-145	88	30-145
Carbon disulfide	60	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	97	35-160	96	35-160
Carbon tetrachloride	5	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	83	65-140	111	65-140
Chlorobenzene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	86	80-120	103	80-120
Chloroethane	5*	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	77	60-135	89	60-135
Chloroform	7	**2.6**	**2.7 J**	**12**	**12**	**2.9**	**10**	**10**	87	65-135	100	65-135
Chloromethane	5*	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	77	40-125	97	40-125
cis-1,2-Dichloroethene	5*	**6.0**	**1.4 J**	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	87	70-125	103	70-125
cis-1,3-Dichloropropene	0.4**	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	86	70-130	95	70-130
Cyclohexane	NGV	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	88	70-130	106	70-130
Dibromochloromethane	50	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	91	60-135	105	60-135
Dichlorodifluoromethane	5*	1.0 UJ	NA	1.0 UJ	1.0 UJ	1.0 UJ	1.0 UJ	1.0 UJ	71	30-155	97	30-155
Ethylbenzene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	85	75-125	107	75-125
Isopropylbenzene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	87	75-125	104	75-125
m,p-Xylene	5*	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	85	75-130	106	75-130
Methyl acetate	NGV	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	78	70-130	80	70-130
Methyl tert-butyl ether	10	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	87	65-125	102	65-125
Methylcyclohexane	NGV	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	87	70-130	109	70-130
Methylene chloride	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	84	55-140	98	55-140
n-Butylbenzene	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
n-Propylbenzene	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
sec-Butylbenzene	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
o-Xylene	5*	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	86	80-120	104	80-120
Styrene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	85	65-135	104	65-135
tert-Butylbenzene	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
Tetrachloroethene	5*	**320 D**	**42**	**14**	**14**	**9.0**	**2.4**	**6.1**	84	45-150	102	45-150
Toluene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	86	75-120	100	75-120
trans-1,2-Dichloroethene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	85	60-140	101	60-140
trans-1,3-Dichloropropene	0.4**	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	88	55-140	101	55-140
Trichloroethene	5*	**6.5**	**1.4 J**	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	84	70-125	99	70-125
Trichlorofluoromethane	5*	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	87	60-145	135	60-145
Vinyl chloride	2	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	82	50-145	89	50-145
Xylene (Total)	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	

Notes:

All results are in micrograms per liter (µg/L) or parts per billion (ppb).

Analytical results are compared against NYSDEC Division of Water Technicall and Operation Guidance Series (T.O.G.S.) 1.1.1 June 1998 Ambient Water Quality Standards.

NGV - No Guidance Value provided by NYSDEC T.O.G.S. 1.1.1.

NA - Not analyzed.

Bold - Indicates analyte detected by laboratory.

Shaded - Indicates the reported value exceeds the associated T.O.G.S. value.

U - Not detected at laboratory method detection limit.

J - Data indicates the presence of a compound that meets the identification criteria. The result is less than the quantitation limit but greater than MDL. The concentration given is an approximate value.

D - Indicates analysis performed under secondary dilution.

E - Indicates reported concentration was outside calibration limits.

* - Indicates the principal organic contaminant standard for groundwater of 5 µg/L applies to this substance.

** - Applies to the sum of cis- and trans-1,3-Dichloropropene.

^ - Indicates percent recovery was outside of the laboratory quality control limits.

Table 2
Groundwater Analytical Results
VOCs by Method 8260
192 Ralph Avenue Off-Site Plume Trackdown
September 2012, February 2013, and September 2013

Site ID		MW-1	MW-1		MW-1		MW-2	MW-3	MW-3	MW-3	MW-4	MW-4
Field Sample ID		MW-1 021213	MW-1 021213 MS		MW-1 021213 MSD		MW-2 021213	MW-3 021213	GW Duplicate-1	MW-3 091013	MW-4 021213	MW-4 090913
Sample Date		2/12/2013	2/12/2013		2/12/2013		2/12/2013	2/12/2013	2/12/2013	9/10/2013	2/12/2013	9/9/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Matrix Spike		Matrix Spike Duplicate		Primary	Primary	Duplicate	Primary	Primary	Primary
			% Rec.	QC lim.	% Rec.	QC lim.						
1,1,1-Trichloroethane	5*	5.0 U	98	65-130	110	65-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2,2-Tetrachloroethane	5*	5.0 U	99	65-130	84	65-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5*	5.0 U	95	70-130	85	70-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2-Trichloroethane	1	NA	NA		NA		NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	5*	5.0 U	99	70-135	105	70-135	5.0 U	5.0 U	5.0 UJ	5.0 U	5.0 U	5.0 U
1,1-Dichloroethene	5*	5.0 U	100	70-130	97	70-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2,3-Trichlorobenzene	5*	5.0 U	99	55-140	94	55-140	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2,3-Trichloropropane	0.04	5.0 U	94	75-125	84	75-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2,4-Trichlorobenzene	5*	5.0 U	100	65-135	97	65-135	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2,4-Trimethylbenzene	5*	5.0 U	102	75-130	108	75-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dibromo-3-chloropropane	0.04	NA	NA		NA		NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	0.0006	NA	NA		NA		NA	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	3	5.0 U	97	70-120	98	70-120	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dichloroethane	0.6	5.0 U	97	70-130	112	70-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dichloropropane	1	5.0 U	99	75-125	106	75-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,3,5-Trimethylbenzene	5*	5.0 U	98	75-130	104	75-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,3-Dichlorobenzene	3	5.0 U	96	75-125	99	75-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,3-Dichloropropane	5*	5.0 U	98	75-125	97	75-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,4-Dichlorobenzene	3	5.0 U	92	75-125	97	75-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,4-Dioxane	NGV	100 U	99	70-130	58 ^	70-130	100 UJ	100 UJ	100 UJ	100 U	100 UJ	100 U
2-Butanone	50	5.0 U	97	30-150	77	30-150	5.0 UJ	5.0 UJ	5.0 U	5.0 U	5.0 UJ	5.0 U
4-Isopropyltoluene	5*	5.0 U	101	75-130	105	75-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Hexanone	50	NA	NA		NA		NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	NGV	5.0 U	99	60-135	81	60-135	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Acetone	50	5.0 U	85	40-140	61	40-140	5.0 UJ	5.0 UJ	5.0 UJ	5.0 U	5.0 UJ	5.0 U
Benzene	1	5.0 U	99	80-120	105	80-120	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bromochloromethane	5*	NA	NA		NA		NA	NA	NA	NA	NA	NA
Bromodichloromethane	50	NA	NA		NA		NA	NA	NA	NA	NA	NA
Bromoform	50	NA	NA		NA		NA	NA	NA	NA	NA	NA
Bromomethane	5*	NA	NA		NA		NA	NA	NA	NA	NA	NA
Carbon disulfide	60	5.0 U	97	35-160	97	35-160	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Carbon tetrachloride	5	5.0 U	101	65-140	111	65-140	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chlorobenzene	5*	5.0 U	95	80-120	99	80-120	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chloroethane	5*	NA	NA		NA		NA	NA	NA	NA	NA	NA
Chloroform	7	**3.7 J**	98	65-135	110	65-135	**17**	**8.3**	**8.3**	**7.7**	**4.6 J**	**6.1**
Chloromethane	5*	NA	NA		NA		NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	5*	5.0 U	99	70-125	103	70-125	5.0 U	5.0 U	5.0 U	5.0 U	**1.5 J**	5.0 U
cis-1,3-Dichloropropene	0.4**	NA	NA		NA		NA	NA	NA	NA	NA	NA
Cyclohexane	NGV	NA	NA		NA		NA	NA	NA	NA	NA	NA
Dibromochloromethane	50	5.0 U	98	60-135	101	60-135	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Dichlorodifluoromethane	5*	NA	NA		NA		NA	NA	NA	NA	NA	NA
Ethylbenzene	5*	5.0 U	96	75-125	100	75-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Isopropylbenzene	5*	5.0 U	101	75-125	108	75-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
m,p-Xylene	5*	NA	NA		NA		NA	NA	NA	NA	NA	NA
Methyl acetate	NGV	NA	NA		NA		NA	NA	NA	NA	NA	NA
Methyl tert-butyl ether	10	5.0 U	98	65-125	94	65-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylcyclohexane	NGV	NA	NA		NA		NA	NA	NA	NA	NA	NA
Methylene chloride	5*	5.0 U	95	55-140	99	55-140	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
n-Butylbenzene	5*	5.0 U	102	70-135	106	70-135	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
n-Propylbenzene	5*	5.0 U	99	70-130	99	70-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
sec-Butylbenzene	5*	5.0 U	103	70-125	106	70-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
o-Xylene	5*	NA	NA		NA		NA	NA	NA	NA	NA	NA
Styrene	5*	5.0 U	93	65-135	99	65-135	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
tert-Butylbenzene	5*	5.0 U	101	70-130	104	70-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Tetrachloroethene	5*	**2.0 J**	93	45-150	96	45-150	5.0 U	**26**	**25**	**12**	**97**	**50**
Toluene	5*	5.0 U	100	75-120	106	75-120	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
trans-1,2-Dichloroethene	5*	5.0 U	98	60-140	102	60-140	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
trans-1,3-Dichloropropene	0.4**	NA	NA		NA		NA	NA	NA	NA	NA	NA
Trichloroethene	5*	**0.56 J**	93	70-125	97	70-125	5.0 U	**0.61 J**	**0.60 J**	5.0 U	**2.0 J**	**0.86 J**
Trichlorofluoromethane	5*	NA	NA		NA		NA	NA	NA	NA	NA	NA
Vinyl chloride	2	5.0 U	93	50-145	93	50-145	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Xylene (Total)	5*	5.0 U	97	81-121	103	81-121	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U

Notes:

All results are in micrograms per liter (µg/L) or parts per billion (ppb).

Analytical results are compared against NYSDEC Division of Water Technical and Operation Guidance Series (T.O.G.S.) 1.1.1 June 1998 Ambient Water Quality Standards.

NGV - No Guidance Value provided by NYSDEC T.O.G.S. 1.1.1.

NA - Not analyzed.

Bold - Indicates analyte detected by laboratory.

Shaded - Indicates the reported value exceeds the associated T.O.G.S. value.

U - Not detected at laboratory method detection limit.

J - Data indicates the presence of a compound that meets the identification criteria. The result is less than the quantitation limit but greater than MDL. The concentration given is an approximate value.

D - Indicates analysis performed under secondary dilution.

E - Indicates reported concentration was outside calibration limits.

* - Indicates the principal organic contaminant standard for groundwater of 5 µg/L applies to this substance.

** - Applies to the sum of cis- and trans-1,3-Dichloropropene.

^ - Indicates percent recovery was outside of the laboratory quality control limits.

Table 2
Groundwater Analytical Results
VOCs by Method 8260
192 Ralph Avenue Off-Site Plume Trackdown
September 2012, February 2013, and September 2013

	Site ID	MW-5	MW-5	MW-7	MW-7	MW-7	MW-7	MW-7	MW-8	MW-8
	Field Sample ID	MW-5 021313	MW-5 091213	MW-7 021313	MW-7 091013	MW-7 091013DL	Duplicate 01	Duplicate 01DL	MW-8 021313	MW-8 090913
	Sample Date	2/13/2013	9/12/2013	2/13/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	2/13/2013	9/9/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary	Primary	Primary	Dilution	Field Duplicate	Dilution (Field Duplicate)	Primary	Primary
1,1,1-Trichloroethane	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,1,2,2-Tetrachloroethane	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,1,2-Trichloroethane	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,1-Dichloroethene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,2,3-Trichlorobenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,2,3-Trichloropropane	0.04	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,2,4-Trichlorobenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,2,4-Trimethylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,2-Dibromo-3-chloropropane	0.04	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	0.0006	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	3	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,2-Dichloroethane	0.6	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,2-Dichloropropane	1	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,3,5-Trimethylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,3-Dichlorobenzene	3	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,3-Dichloropropane	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,4-Dichlorobenzene	3	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,4-Dioxane	NGV	100 UJ	100 U	100 UJ	100 U	200 U	100 U	200 U	100 UJ	100 U
2-Butanone	50	5.0 UJ	5.0 U	5.0 UJ	5.0 U	10 U	5.0 U	10 U	5.0 UJ	5.0 U
4-Isopropyltoluene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
2-Hexanone	50	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	NGV	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Acetone	50	5.0 UJ	5.0 U	5.0 UJ	5.0 U	10 U	5.0 U	10 U	5.0 UJ	5.0 U
Benzene	1	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Bromochloromethane	5*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	50	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromoform	50	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromomethane	5*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	60	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Carbon tetrachloride	5	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Chlorobenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Chloroethane	5*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	7	**2.0 J**	**2.9 J**	**0.69 J**	**0.59 J**	10 U	**0.60 J**	10 U	**5.3**	**3.7 J**
Chloromethane	5*	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	5*	**0.83 J**	**1.6 J**	**2.9 J**	**4.5 J**	**3.9 DJ**	**4.4 J**	**4.2 DJ**	5.0 U	5.0 U
cis-1,3-Dichloropropene	0.4**	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cyclohexane	NGV	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	50	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Dichlorodifluoromethane	5*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Isopropylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
m,p-Xylene	5*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl acetate	NGV	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl tert-butyl ether	10	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Methylcyclohexane	NGV	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methylene chloride	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
n-Butylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
n-Propylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
sec-Butylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
o-Xylene	5*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Styrene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
tert-Butylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Tetrachloroethene	5*	**72**	**140**	**280 D**	**270 E**	**230 D**	**270 E**	**270 D**	**19**	**15**
Toluene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
trans-1,2-Dichloroethene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
trans-1,3-Dichloropropene	0.4**	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	5*	**1.4 J**	**2.8 J**	**5.9**	**6.1**	**5.2 DJ**	**6.0**	**5.7 DJ**	**0.53 J**	5.0 U
Trichlorofluoromethane	5*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl chloride	2	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Xylene (Total)	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U

Notes:

All results are in micrograms per liter (μg/L) or parts per billion (ppb).

Analytical results are compared against NYSDEC Division of Water Technical and Operation Guidance Series (T.O.G.S.) 1.1.1 June 1998 Ambient Water Quality Standards.

NGV - No Guidance Value provided by NYSDEC T.O.G.S. 1.1.1.

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Bold - Indicates analyte detected by laboratory.

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D - Indicates analysis performed under secondary dilution.

E - Indicates reported concentration was outside calibration limits.

* - Indicates the principal organic contaminant standard for groundwater of 5 μg/L applies to this substance.

** - Applies to the sum of cis- and trans-1,3-Dichloropropene.

^ - Indicates percent recovery was outside of the laboratory quality control limits.

Table 2
Groundwater Analytical Results
VOCs by Method 8260
192 Ralph Avenue Off-Site Plume Trackdown
September 2012, February 2013, and September 2013

Site ID		MW-9	MW-9	MW-10	MW-10	MW-10		MW-10	
Field Sample ID		MW-9 021313	MW-9 091013	MW-10 021313	MW-10 091013	MW-10 091013		MW-10 091013	
Sample Date		2/13/2013	9/10/2013	2/13/2013	9/10/2013	9/10/2013		9/10/2013	
	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary	Primary	Primary	Matrix Spike		Matrix Spike Duplicate	
Analyte						% Rec.	QC lim.	% Rec.	QC lim.
1,1,1-Trichloroethane	5*	5.0 U	5.0 U	5.0 U	5.0 U	84	65 - 130	87	65 - 130
1,1,2,2-Tetrachloroethane	5*	5.0 U	5.0 U	5.0 U	5.0 U	85	65 - 130	94	65 - 130
1,1,2-Trichloro-1,2,2-trifluoroethane	5*	5.0 U	5.0 U	5.0 U	5.0 U	59 ^	70 - 130	66 ^	70 - 130
1,1,2-Trichloroethane	1	NA	NA	NA	NA	NA		NA	
1,1-Dichloroethane	5*	5.0 U	5.0 U	5.0 U	5.0 U	76	70 - 135	78	70 - 135
1,1-Dichloroethene	5*	5.0 U	5.0 U	5.0 U	5.0 U	75	70 - 130	76	70 - 130
1,2,3-Trichlorobenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	102	55 - 140	104	55 - 140
1,2,3-Trichloropropane	0.04	5.0 U	5.0 U	5.0 U	5.0 U	90	75 - 125	94	75 - 125
1,2,4-Trichlorobenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	93	65 - 135	96	65 - 135
1,2,4-Trimethylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	95	75 - 130	98	75 - 130
1,2-Dibromo-3-chloropropane	0.04	NA	NA	NA	NA	NA		NA	
1,2-Dibromoethane	0.0006	NA	NA	NA	NA	NA		NA	
1,2-Dichlorobenzene	3	5.0 U	5.0 U	5.0 U	5.0 U	97	70 - 120	101	70 - 120
1,2-Dichloroethane	0.6	5.0 U	5.0 U	5.0 U	5.0 U	99	70 - 130	103	70 - 130
1,2-Dichloropropane	1	5.0 U	5.0 U	5.0 U	5.0 U	68 ^	75 - 125	71	75 - 125
1,3,5-Trimethylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	92	75 - 130	96	75 - 130
1,3-Dichlorobenzene	3	5.0 U	5.0 U	5.0 U	5.0 U	94	75 - 125	97	75 - 125
1,3-Dichloropropane	5*	5.0 U	5.0 U	5.0 U	5.0 U	99	75 - 125	98	75 - 125
1,4-Dichlorobenzene	3	5.0 U	5.0 U	5.0 U	5.0 U	93	75 - 125	96	75 - 125
1,4-Dioxane	NGV	100 UJ	100 U	100 UJ	100 U	72	70 - 130	78	70 - 130
2-Butanone	50	5.0 UJ	5.0 U	5.0 UJ	5.0 U	65	30 - 150	65	30 - 150
4-Isopropyltoluene	5*	5.0 U	5.0 U	5.0 U	5.0 U	91	75 - 130	95	75 - 130
2-Hexanone	50	NA	NA	NA	NA	NA		NA	
4-Methyl-2-pentanone	NGV	5.0 U	5.0 U	5.0 U	5.0 U	92	60 - 135	98	60 - 135
Acetone	50	5.0 UJ	5.0 U	5.0 UJ	5.0 U	68	40 - 140	69	40 - 140
Benzene	1	5.0 U	5.0 U	5.0 U	5.0 U	67 ^	80 - 120	68	80 - 120
Bromochloromethane	5*	NA	NA	NA	NA	NA		NA	
Bromodichloromethane	50	NA	NA	NA	NA	NA		NA	
Bromoform	50	NA	NA	NA	NA	NA		NA	
Bromomethane	5*	NA	NA	NA	NA	NA		NA	
Carbon disulfide	60	5.0 U	5.0 U	5.0 U	5.0 U	57	35 - 160	57	35 - 160
Carbon tetrachloride	5	5.0 U	5.0 U	5.0 U	5.0 U	86	65 - 140	88	65 - 140
Chlorobenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	92	80 - 120	96	80 - 120
Chloroethane	5*	NA	NA	NA	NA	NA		NA	
Chloroform	7	**1.2 J**	**0.92 J**	**0.77 J**	**1.6 J**	79	65 - 135	81	65 - 135
Chloromethane	5*	NA	NA	NA	NA	NA		NA	
cis-1,2-Dichloroethene	5*	**3.3 J**	**2.1 J**	5.0 U	5.0 U	69 ^	70 - 125	70	70 - 125
cis-1,3-Dichloropropene	0.4**	NA	NA	NA	NA	NA		NA	
Cyclohexane	NGV	NA	NA	NA	NA	NA		NA	
Dibromochloromethane	50	5.0 U	5.0 U	5.0 U	5.0 U	102	60 - 135	102	60 - 135
Dichlorodifluoromethane	5*	NA	NA	NA	NA	NA		NA	
Ethylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	91	75 - 125	89	75 - 125
Isopropylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	95	75 - 125	94	75 - 125
m,p-Xylene	5*	NA	NA	NA	NA	NA		NA	
Methyl acetate	NGV	NA	NA	NA	NA	NA		NA	
Methyl tert-butyl ether	10	5.0 U	5.0 U	5.0 U	5.0 U	75	65 - 125	78	65 - 125
Methylcyclohexane	NGV	NA	NA	NA	NA	NA		NA	
Methylene chloride	5*	5.0 U	5.0 U	5.0 U	5.0 U	61	55 - 140	64	55 - 140
n-Butylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	85	70 - 135	89	70 - 135
n-Propylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	88	70 - 130	92	70 - 130
sec-Butylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	89	70 - 125	92	70 - 125
o-Xylene	5*	NA	NA	NA	NA	NA		NA	
Styrene	5*	5.0 U	5.0 U	5.0 U	5.0 U	88	65 - 135	88	65 - 135
tert-Butylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	93	70 - 130	96	70 - 130
Tetrachloroethene	5*	**160**	**130**	**12**	**22**	83	45 - 150	80	45 - 150
Toluene	5*	5.0 U	5.0 U	5.0 U	5.0 U	68 ^	75 - 120	71	75 - 120
trans-1,2-Dichloroethene	5*	**1.8 J**	5.0 U	5.0 U	5.0 U	61	60 - 140	63	60 - 140
trans-1,3-Dichloropropene	0.4**	NA	NA	NA	NA	NA		NA	
Trichloroethene	5*	**5.7**	**4.5 J**	5.0 U	5.0 U	69 ^	70 - 125	71	70 - 125
Trichlorofluoromethane	5*	NA	NA	NA	NA	NA		NA	
Vinyl chloride	2	5.0 U	5.0 U	5.0 U	5.0 U	69	50 - 145	72	50 - 145
Xylene (Total)	5*	5.0 U	5.0 U	5.0 U	5.0 U	94	81 - 121	94	81 - 121

Notes:

All results are in micrograms per liter (µg/L) or parts per billion (ppb).

Analytical results are compared against NYSDEC Division of Water Technical and Operation Guidance Series (T.O.G.S.) 1.1.1 June 1998 Ambient Water Quality Standards.

NGV - No Guidance Value provided by NYSDEC T.O.G.S. 1.1.1.

NA - Not analyzed.

Bold - Indicates analyte detected by laboratory.

Shaded - Indicates the reported value exceeds the associated T.O.G.S. value.

U - Not detected at laboratory method detection limit.

J - Data indicates the presence of a compound that meets the identification criteria. The result is less than the quantitation limit but greater than MDL. The concentration given is an approximate value.

D - Indicates analysis performed under secondary dilution.

E - Indicates reported concentration was outside calibration limits.

* - Indicates the principal organic contaminant standard for groundwater of 5 µg/L applies to this substance.

** - Applies to the sum of cis- and trans-1,3-Dichloropropene.

^ - Indicates percent recovery was outside of the laboratory quality control limits.

Table 2
Groundwater Analytical Results
VOCs by Method 8260
192 Ralph Avenue Off-Site Plume Trackdown
September 2012, February 2013, and September 2013

Site ID		Trip Blank	Trip Blank	Trip Blank	Trip Blank	Trip Blank
Field Sample ID		T. Blank	Trip Blank 021213	Trip Blank 021313	Trip Blank 091013	TB 091213
Sample Date		9/19/2012	2/12/2013	2/13/2013	9/10/2013	9/12/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Trip Blank	Trip Blank	Trip Blank	Trip Blank	Trip Blank
1,1,1-Trichloroethane	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2,2-Tetrachloroethane	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2-Trichloroethane	1	1.0 U	NA	NA	NA	NA
1,1-Dichloroethane	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1-Dichloroethene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2,3-Trichlorobenzene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2,3-Trichloropropane	0.04	NA	5.0 U	5.0 U	5.0 U	5.0 U
1,2,4-Trichlorobenzene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2,4-Trimethylbenzene	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dibromo-3-chloropropane	0.04	1.0 U	NA	NA	NA	NA
1,2-Dibromoethane	0.0006	1.0 U	NA	NA	NA	NA
1,2-Dichlorobenzene	3	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dichloroethane	0.6	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dichloropropane	1	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,3,5-Trimethylbenzene	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U
1,3-Dichlorobenzene	3	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,3-Dichloropropane	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U
1,4-Dichlorobenzene		1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,4-Dioxane	NGV	100 U	100 U	100 U	100 U	100 U
2-Butanone	50	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
4-Isopropyltoluene	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U
2-Hexanone	50	5.0 U	NA	NA	NA	NA
4-Methyl-2-pentanone	NGV	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Acetone	50	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzene	1	0.70 U	5.0 U	5.0 U	5.0 U	5.0 U
Bromochloromethane	5*	1.0 U	NA	NA	NA	NA
Bromodichloromethane	50	1.0 U	NA	NA	NA	NA
Bromoform	50	1.0 U	NA	NA	NA	NA
Bromomethane	5*	1.0 U	NA	NA	NA	NA
Carbon disulfide	60	1.0 U	**1.1 J**	5.0 U	5.0 U	5.0 U
Carbon tetrachloride	5	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chlorobenzene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chloroethane	5*	1.0 U	NA	NA	NA	NA
Chloroform	7	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chloromethane	5*	1.0 U	NA	NA	NA	NA
cis-1,2-Dichloroethene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
cis-1,3-Dichloropropene	0.4**	1.0 U	NA	NA	NA	NA
Cyclohexane	NGV	1.0 U	NA	NA	NA	NA
Dibromochloromethane	50	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Dichlorodifluoromethane	5*	1.0 U	NA	NA	NA	NA
Ethylbenzene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Isopropylbenzene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
m,p-Xylene	5*	1.0 U	NA	NA	NA	NA
Methyl acetate	NGV	1.0 U	NA	NA	NA	NA
Methyl tert-butyl ether	10	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylcyclohexane	NGV	1.0 U	NA	NA	NA	NA
Methylene chloride	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
n-Butylbenzene	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U
n-Propylbenzene	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U
sec-Butylbenzene	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U
o-Xylene	5*	1.0 U	NA	NA	NA	NA
Styrene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
tert-Butylbenzene	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U
Tetrachloroethene	5*	1.0 U	5.0 U	5.0 U	**1.8 J**	**1.2 J**
Toluene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
trans-1,2-Dichloroethene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
trans-1,3-Dichloropropene	0.4**	1.0 U	NA	NA	NA	NA
Trichloroethene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Trichlorofluoromethane	5*	1.0 U	NA	NA	NA	NA
Vinyl chloride	2	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Xylene (Total)	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U

Notes:

All results are in micrograms per liter (µg/L) or parts per billion (ppb).

Analytical results are compared against NYSDEC Division of Water Technical and Operation Guidance Series (T.O.G.S.) 1.1.1 June 1998 Ambient Water Quality Standards.

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E - Indicates reported concentration was outside calibration limits.

* - Indicates the principal organic contaminant standard for groundwater of 5 µg/L applies to this substance.

** - Applies to the sum of cis- and trans-1,3-Dichloropropene.

^ - Indicates percent recovery was outside of the laboratory quality control limits.

1.0 Purpose

This calculation estimates the amount of potassium permanganate or sodium permanganate to inject at a chlorinated hydrocarbon plume in groundwater at the 192 Ralph Avenue site in Brooklyn, New York under Alternative 4.

2.0 Data and Assumptions

2.1 Data

- Target compounds are Tetrachloroethene, Trichloroethene, Chloroform, and cis-1,2-Dichloroethene. Contaminant concentrations are assumed to be 0.1 mg/L based on typical concentrations detected on site (Ref. 1). It is noted that the oxidant demand is primarily driven by the natural demand, no the contaminants' demand.

- The aquifer thickness at the site is 30 feet (Ref 1).

2.2 Assumptions

- The treatment would be conducted within an area of approximately 8.53 acres, or 371,566 ft^2. The reagent would be injected using direct push injection points, at depths approximately 35 feet bgs to 60 feet bgs to treat the full thickness of the aquifer.

- The total and effective porosity of the soil is estimated to be approximately 30%.

- Natural Oxidant Demand is assumed to be 1 mg/kg.

3.0 Calculations

The amount of potassium permanganate or sodium permanganate to be injected in the treatment area is determined using the estimated mass of dissolved levels of contamination and, more importantly, the assumed oxidant demand.

The amount of permanganate is calculated using an excel spreadsheet provided by Carus Remediation Technologies (CRT), a supplier of permanganate. The length and width of the treatment area were set to result in a total area of 371,566 ft^2 which is the area of treatment shown on Figure 1, as calculated in CAD. The thickness of the treatment area is the aquifer thickness of 30 feet. A typical value of 30% was assumed for the porosity of the soil. A conservative estimation of the average contaminant concentration of 0.1 ppm was used based on the RI results. Permanganate natural oxidant demand (PNOD) was assumed to be 1 g/kg. Default values set by CRT were used for effective PNOD (20%), confidence factor (2), and injection concentration (10%). The CRT spreadsheet requires entering the stoichiometric demand for oxidation using potassium permanganate as the oxidant. An average stoichiometric demand of 1.27 lb/lb was calculated based on the following chemical reaction:

$$4KMnO_4 + 3C_2Cl_4 + 4H_2O \rightarrow 6CO_2 + 4MnO_2 + 4K^+ + 8H^+ + 12Cl^-$$

$$4\,mol \times 158\,g/mol\,KMnO_4 = 568\,g\,KMnO_4$$

$$3\,mol \times 165.8\,g/mol\,C_2Cl_4 = 497\,g\,C_2Cl_4$$

$$\frac{568\,g\,KMnO_4}{497\,g\,C_2Cl_4} = 1.27\,g/g = 1.27\,lb/lb$$

The calculation estimates that about 490,520 pounds of (solid) potassium permanganate or 1,101,218 pounds of 40% solution of sodium permanganate would be required.

Sodium permanganate reagent is supplied at a concentration of 40%; however, the lower concentration of 10% helps drive the reagent further into the aquifer because a larger volume is injected. An estimated 483,542 gallons of 10% solution would be required.

4.0 References

1. Shaw Environmental & Infrastructure Engineering of New York, P.C. 2005. *Final Remedial Investigation Report, 192 Ralph Avenue Off-Site Remedial Program, Brooklyn, New York*. Latham, New York.

Calculations

CRT

Carus Remediation Technologies

RemOx® S and RemOx® L ISCO Reagents Estimation Spreadsheet

Input data into box with black font

Site Name: 192 Ralph Avenue - Alternative 4

Date: 5/17/2017

	Estimates	Units
Treatment Area Volume		
Length	**806**	ft
Width	**461**	ft
Area	371,566	sq ft
Thickness	**30**	ft
Total Volume	412,851	cu yd
Soil Characteristics/Analysis		
Porosity	**30**	%
Total Plume Pore Volume	25,015,557	gal
Avg Contaminant Conc	**0.1**	ppm
Mass of Contaminant	20.88	lb
PNOD	**1**	g/kg
Effective PNOD	**20**	%
Effective PNOD Calculated	0.200	
PNOD Oxidant Demand	245,233.56	lb
Avg Stoichiometric Demand	**1.27**	lb/lb
Contaminant Oxidant Demand	26.51	lb
Theoretical Oxidant Demand	245,260.07	lb
Confidence Factor	**2**	
Calculated Oxidant Demand	490,520.15	

	Estimates	Units
Injection Volume for RemOx S		
Injection Concentration	**1.0%**	%
Total Volume of Injection Fluid	5,881,537	gal
Pore Volume Replaced	23.51	%
Amount of RemOx S Estimated:	**490,520**	**pounds**
Injection Volume for RemOx L		
Injection Concentration	**10.0%**	%
Calculated Specific Gravity	1.09	g/ml
Total Volume of Injection Fluid	483,542	gal
Pore Volume Replaced	1.93	%
Amount of RemOx L Estimated:	**1,101,218**	**pounds**
	96,345	**gallons**

Reference 1

Shaw Environmental & Infrastructure Engineering of New York, P.C.
13 British American Boulevard
Latham, NY 12110-1405
Tel: +1 518 783 1996
Fax: +1 518 783 8397
www.CBI.com

FINAL REMEDIAL INVESTIGATION REPORT

192 Ralph Avenue Off-Site Remedial Program
Brooklyn, Kings County, NY
Site Number 224042
Contract Work Authorization Number: D006132-28

Shaw Project No.: 134685.28

September 2015

Prepared for:

Robert Filkins
New York State Department of Environmental Conservation
Division of Environmental Remediation
Bureau of Program Management, Room 1224
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Latham, New York, 12110

1.0 INTRODUCTION

Shaw Environmental & Infrastructure Engineering of New York, P.C. (Shaw) has prepared this Remedial Investigation (RI) Report summarizing collection and analysis of soil, groundwater, soil vapor and indoor air media for volatile organic compounds (VOCs) at the 192 Ralph Avenue Off-site Remedial Program (Site Number 224042) site located in Brooklyn, Kings County, New York (Site) (**Figure 1**). The primary purpose of the RI was to determine the extent of off-site impacts from contamination prior to and after startup of the soil vapor extraction (SVE) system that was installed at 192 Ralph Avenue to mitigate air quality. The scope of work discussed herein was developed in accordance with Work Assignment (WA) D006132-28 provided to Shaw on April 12, 2012, various discussions with the NYSDEC, the June 28, 2012 approved work plan (i.e. executive summary) and the February 4, 2013 amended work plan (i.e. Amendment 1)

1.1 Description and Location

Site Description

The Site is located in the Bedford-Stuyvesant section of Brooklyn, NY along Ralph Avenue between the main thoroughfares of Macon Street to the north, Marion Street to the south, Patchen Avenue to the west and Howard Avenue to the east. The off-site area of investigation is comprised of a mixture of residential and commercial properties.

Site Geology

Located in the Atlantic Coastal Plain Physiographic Province, the Pre-Cambrian Age metamorphic bedrock is believed to be over 200-feet below ground surface (bgs) at the Site. The soils at the Site have been classified as urban fill, consisting of construction debris, rock, and ash. The urban fill reaches approximately 7-feet bgs, underlain by glacial deposits consisting primarily of silt, sand and gravel. Groundwater is present in the fill and glacial deposits, occurring at depths of approximately 9-feet to 15-feet bgs. Predominant regional groundwater flow direction is toward the north-northwest, with the deep groundwater flowing north.

The geology of the Site consists of outwash sand and gravel deposits. Highly permeable fine to medium sands with some gravel appear above a confining layer of silty clay about 60 to 70-feet below ground surface (bgs). Localized groundwater flows south-southeast and is encountered 35 to 40-feet bgs.

relocated four feet south. This point was relocated for a third time directly across Decatur Street to the north where it was successfully advanced to 50-ft bgs. At SB-6, refusal was encountered once at 15-ft bgs, but the boring was successfully advanced after moving the point three feet to the west. Drill logs, which provide a more detailed account soil types and other observations, have been included as **Appendix G**.

3.2 Groundwater Sampling

Three separate groundwater sampling events were conducted at the Site. During the first event (October 2012), groundwater samples were collected from five existing piezometers. In February 2013, Shaw collected samples from the nine newly installed monitoring wells (MW-1 through MW-5 and MW-7 through MW-10. Lastly, samples were collected from monitoring wells MW-3, MW-4, MW-5, MW-7, MW-8, MW-9, and MW-10 and piezometer PZ-1 in September 2013. All samples were analyzed by Spectrum for VOCs by USEPA Method 8260B. The analytical results are summarized and compared to NYSDEC New York State Groundwater Quality Standard (NYSGWQS) as defined in the Technical and Operational Guidance Series (TOGS) 1.1.1 for VOCs on **Table 2**, and shown graphically on **Figure 4**. The complete analytical data package is included in **Appendix D**.

3.2.1 Phase I - September 2012

Several analytes were detected at concentrations exceeding NYSGWQS including chloroform, cis-1,2-dichloroethene, PCE, and TCE. There were several other compounds for which the laboratory result was reported as "non-detect", but the reporting limit exceeded groundwater quality standards. Detection ranges (minimum-maximum) in micrograms per liter (µg/L) or ppb for these compounds are summarized as follows:

- Chloroform - 2.6 µg/L to 12 µg/L at PZ-2;
- cis-1,2-Dichloroethene – Non-detect to 6.0 µg/L at PZ-1;
- PCE – 2.4 µg/L to 320D µg/L at PZ-1DL; and
- TCE – Non-detect to 6.5 µg/L at PZ-1

3.2.2 Phase II – February 2013

Analytes detected at concentrations exceeding NYSGWQS included chloroform, PCE, and TCE. There were several other compounds for which the laboratory result was reported as "non-detect", but the reporting limit exceeded groundwater quality standards. Detection ranges (minimum-maximum) in µg/L or ppb for these compounds are summarized as follows:

- Chloroform – 0.69 µg/L at MW-7 to 17 µg/L at MW-2;
- cis-1,2-Dichloroethene – Non-detect to 3.3J µg/L at MW-9;
- PCE – Non-detect to 280D µg/L at MW-7; and
- TCE – Non-detect to 5.9 µg/L at MW-7

3.2.3 Phase II – September 2013

Analytes detected at concentrations exceeding NYSGWQS included chloroform, PCE, and TCE. There were several other compounds for which the laboratory result was reported as "non-detect", but the reporting limit exceeded groundwater quality standards. Detection ranges (minimum-maximum) in µg/L or ppb for these compounds are summarized as follows:

- Chloroform – 0.59 µg/L at MW-7 to 7.7 µg/L at MW-3;
- cis-1,2-Dichloroethene – Non-detect to 4.5J µg/L at MW-7;
- PCE – 12 µg/L at MW-3 to 230D µg/L at MW-7; and,
- TCE – Non-detect to 6.1 µg/L at MW-7

3.2.4 Site Hydrogeology

Due to a low groundwater gradient a contour map could not be produced from the gauging results obtained during the February 2013 visit. Specifically, the change in water table elevation across the area is 0.56 feet; this flat elevation, combined with the relatively small size of the Site, topography and paving of the Site all combine to make the development of meaningful groundwater contours problematic. The data shows a groundwater flow direction toward the southeast which is generally consistent with historic gauging data.

3.3 Vapor Phase Sampling Results

The analytical results presented in micrograms per cubic meter ($\mu g/m^3$) for the soil vapor and ambient air samples are summarized on **Table 3**; complete analytical data package are included as **Appendix E**. Compounds detected as part of the air sampling are also presented on **Figure 5**.

Table 2
Groundwater Analytical Results
VOCs by Method 8260
192 Ralph Avenue Off-Site Plume Trackdown
September 2012, February 2013, and September 2013

	Site ID	PZ-1	PZ-1	PZ-2	PZ-2	PZ-3	PZ-4	PZ-5	PZ-5		PZ-5	
	Field Sample ID	PZ-1	PZ-1 091013	PZ-2	Duplicate	PZ-3	PZ-4	PZ-5	MS-PZ-5		MSD-PZ-5	
	Sample Date	9/20/2012	9/10/2013	9/19/2012	9/19/2012	9/19/2012	9/19/2012	9/19/2012	9/19/2012		9/19/2012	
	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary	Primary	Duplicate	Primary	Primary	Primary	Matrix Spike		Matrix Spike Duplicate	
Analyte									% Rec.	QC lim.	% Rec.	QC lim.
1,1,1-Trichloroethane	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	85	65-130	102	65-130
1,1,2,2-Tetrachloroethane	5*	1.0 UJ	5.0 U	1.0 UJ	1.0 UJ	1.0 UJ	1.0 UJ	1.0 UJ	95	65-130	99	65-130
1,1,2-Trichloro-1,2,2-trifluoroethane	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	84	70-130	105	70-130
1,1,2-Trichloroethane	1	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	93	75-125	88	75-125
1,1-Dichloroethane	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	85	70-135	97	70-135
1,1-Dichloroethene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	84	70-130	105	70-130
1,2,3-Trichlorobenzene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	76	55-140	91	55-140
1,2,3-Trichloropropane	0.04	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
1,2,4-Trichlorobenzene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	78	65-135	95	65-135
1,2,4-Trimethylbenzene	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
1,2-Dibromo-3-chloropropane	0.04	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	91	50-130	90	50-130
1,2-Dibromoethane	0.0006	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	95	80-120	99	80-120
1,2-Dichlorobenzene	3	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	84	70-120	102	70-120
1,2-Dichloroethane	0.6	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	89	70-130	103	70-130
1,2-Dichloropropane	1	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	87	75-125	101	75-125
1,3,5-Trimethylbenzene	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
1,3-Dichlorobenzene	3	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	81	75-125	97	75-125
1,3-Dichloropropane	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
1,4-Dichlorobenzene	3	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	82	75-125	96	75-125
1,4-Dioxane	NGV	100 U	100 U	100 U	100 UJ	100 U	100 U	100 U	52 ^	70-130	94	70-130
2-Butanone	50	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	88	30-150	95	30-150
4-Isopropyltoluene	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
2-Hexanone	50	5.0 U	NA	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	94	55-130	90	55-130
4-Methyl-2-pentanone	NGV	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	93	60-135	91	60-135
Acetone	50	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	78	40-140	67	40-140
Benzene	1	0.70 U	5.0 U	0.70 U	0.70 U	0.70 U	0.70 U	0.70 U	85	80-120	102	80-120
Bromochloromethane	5*	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	92	65-130	103	65-130
Bromodichloromethane	50	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	88	75-120	99	75-120
Bromoform	50	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	90	70-130	104	70-130
Bromomethane	5*	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	77	30-145	88	30-145
Carbon disulfide	60	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	97	35-160	96	35-160
Carbon tetrachloride	5	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	83	65-140	111	65-140
Chlorobenzene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	86	80-120	103	80-120
Chloroethane	5*	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	77	60-135	89	60-135
Chloroform	7	**2.6**	**2.7 J**	**12**	**12**	**2.9**	**10**	**10**	87	65-135	100	65-135
Chloromethane	5*	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	77	40-125	97	40-125
cis-1,2-Dichloroethene	5*	**6.0**	**1.4 J**	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	87	70-125	103	70-125
cis-1,3-Dichloropropene	0.4**	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	86	70-130	95	70-130
Cyclohexane	NGV	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	88	70-130	106	70-130
Dibromochloromethane	50	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	91	60-135	105	60-135
Dichlorodifluoromethane	5*	1.0 UJ	NA	1.0 UJ	1.0 UJ	1.0 UJ	1.0 UJ	1.0 UJ	71	30-155	97	30-155
Ethylbenzene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	85	75-125	107	75-125
Isopropylbenzene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	87	75-125	104	75-125
m,p-Xylene	5*	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	85	75-130	106	75-130
Methyl acetate	NGV	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	78	70-130	80	70-130
Methyl tert-butyl ether	10	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	87	65-125	102	65-125
Methylcyclohexane	NGV	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	87	70-130	109	70-130
Methylene chloride	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	84	55-140	98	55-140
n-Butylbenzene	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
n-Propylbenzene	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
sec-Butylbenzene	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
o-Xylene	5*	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	86	80-120	104	80-120
Styrene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	85	65-135	104	65-135
tert-Butylbenzene	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	
Tetrachloroethene	5*	**320 D**	**42**	**14**	**14**	**9.0**	**2.4**	**6.1**	84	45-150	102	45-150
Toluene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	86	75-120	100	75-120
trans-1,2-Dichloroethene	5*	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	85	60-140	101	60-140
trans-1,3-Dichloropropene	0.4**	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	88	55-140	101	55-140
Trichloroethene	5*	**6.5**	**1.4 J**	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	84	70-125	99	70-125
Trichlorofluoromethane	5*	1.0 U	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	87	60-145	135	60-145
Vinyl chloride	2	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	82	50-145	89	50-145
Xylene (Total)	5*	NA	5.0 U	NA	NA	NA	NA	NA	NA		NA	

Notes:

All results are in micrograms per liter (µg/L) or parts per billion (ppb).

Analytical results are compared against NYSDEC Division of Water Technical and Operation Guidance Series (T.O.G.S.) 1.1.1 June 1998 Ambient Water Quality Standards.

NGV - No Guidance Value provided by NYSDEC T.O.G.S. 1.1.1.

NA - Not analyzed.

Bold - Indicates analyte detected by laboratory.

Shaded - Indicates the reported value exceeds the associated T.O.G.S. value.

U - Not detected at laboratory method detection limit.

J - Data indicates the presence of a compound that meets the identification criteria. The result is less than the quantitation limit but greater than MDL. The concentration given is an approximate value.

D - Indicates analysis performed under secondary dilution.

E - Indicates reported concentration was outside calibration limits.

* - Indicates the principal organic contaminant standard for groundwater of 5 µg/L applies to this substance.

** - Applies to the sum of cis- and trans-1,3-Dichloropropene.

^ - Indicates percent recovery was outside of the laboratory quality control limits.

Table 2
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VOCs by Method 8260
192 Ralph Avenue Off-Site Plume Trackdown
September 2012, February 2013, and September 2013

Site ID		MW-1	MW-1		MW-1		MW-2	MW-3	MW-3	MW-3	MW-4	MW-4
Field Sample ID		MW-1 021213	MW-1 021213 MS		MW-1 021213 MSD		MW-2 021213	MW-3 021213	GW Duplicate-1	MW-3 091013	MW-4 021213	MW-4 090913
Sample Date		2/12/2013	2/12/2013		2/12/2013		2/12/2013	2/12/2013	2/12/2013	9/10/2013	2/12/2013	9/9/2013
	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Matrix Spike		Matrix Spike Duplicate		Primary	Primary	Duplicate	Primary	Primary	Primary
Analyte			% Rec.	QC lim.	% Rec.	QC lim.						
1,1,1-Trichloroethane	5*	5.0 U	98	65-130	110	65-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2,2-Tetrachloroethane	5*	5.0 U	99	65-130	84	65-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5*	5.0 U	95	70-130	85	70-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2-Trichloroethane	1	NA	NA		NA		NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	5*	5.0 U	99	70-135	105	70-135	5.0 U	5.0 U	5.0 UJ	5.0 U	5.0 U	5.0 U
1,1-Dichloroethene	5*	5.0 U	100	70-130	97	70-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2,3-Trichlorobenzene	5*	5.0 U	99	55-140	94	55-140	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2,3-Trichloropropane	0.04	5.0 U	94	75-125	84	75-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2,4-Trichlorobenzene	5*	5.0 U	100	65-135	97	65-135	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2,4-Trimethylbenzene	5*	5.0 U	102	75-130	108	75-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dibromo-3-chloropropane	0.04	NA	NA		NA		NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	0.0006	NA	NA		NA		NA	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	3	5.0 U	97	70-120	98	70-120	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dichloroethane	0.6	5.0 U	97	70-130	112	70-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dichloropropane	1	5.0 U	99	75-125	106	75-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,3,5-Trimethylbenzene	5*	5.0 U	98	75-130	104	75-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,3-Dichlorobenzene	3	5.0 U	96	75-125	99	75-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,3-Dichloropropane	5*	5.0 U	98	75-125	97	75-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,4-Dichlorobenzene	3	5.0 U	92	75-125	97	75-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,4-Dioxane	NGV	100 U	99	70-130	58 ^	70-130	100 UJ	100 UJ	100 UJ	100 U	100 UJ	100 U
2-Butanone	50	5.0 U	97	30-150	77	30-150	5.0 UJ	5.0 UJ	5.0 U	5.0 U	5.0 UJ	5.0 U
4-Isopropyltoluene	5*	5.0 U	101	75-130	105	75-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Hexanone	50	NA	NA		NA		NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	NGV	5.0 U	99	60-135	81	60-135	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Acetone	50	5.0 U	85	40-140	61	40-140	5.0 UJ	5.0 UJ	5.0 UJ	5.0 U	5.0 UJ	5.0 U
Benzene	1	5.0 U	99	80-120	105	80-120	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bromochloromethane	5*	NA	NA		NA		NA	NA	NA	NA	NA	NA
Bromodichloromethane	50	NA	NA		NA		NA	NA	NA	NA	NA	NA
Bromoform	50	NA	NA		NA		NA	NA	NA	NA	NA	NA
Bromomethane	5*	NA	NA		NA		NA	NA	NA	NA	NA	NA
Carbon disulfide	60	5.0 U	97	35-160	97	35-160	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Carbon tetrachloride	5	5.0 U	101	65-140	111	65-140	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chlorobenzene	5*	5.0 U	95	80-120	99	80-120	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chloroethane	5*	NA	NA		NA		NA	NA	NA	NA	NA	NA
Chloroform	7	**3.7 J**	98	65-135	110	65-135	**17**	**8.3**	**8.3**	**7.7**	**4.6 J**	**6.1**
Chloromethane	5*	NA	NA		NA		NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	5*	5.0 U	99	70-125	103	70-125	5.0 U	5.0 U	5.0 U	5.0 U	**1.5 J**	5.0 U
cis-1,3-Dichloropropene	0.4**	NA	NA		NA		NA	NA	NA	NA	NA	NA
Cyclohexane	NGV	NA	NA		NA		NA	NA	NA	NA	NA	NA
Dibromochloromethane	50	5.0 U	98	60-135	101	60-135	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Dichlorodifluoromethane	5*	NA	NA		NA		NA	NA	NA	NA	NA	NA
Ethylbenzene	5*	5.0 U	96	75-125	100	75-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Isopropylbenzene	5*	5.0 U	101	75-125	108	75-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
m,p-Xylene	5*	NA	NA		NA		NA	NA	NA	NA	NA	NA
Methyl acetate	NGV	NA	NA		NA		NA	NA	NA	NA	NA	NA
Methyl tert-butyl ether	10	5.0 U	98	65-125	94	65-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylcyclohexane	NGV	NA	NA		NA		NA	NA	NA	NA	NA	NA
Methylene chloride	5*	5.0 U	95	55-140	99	55-140	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
n-Butylbenzene	5*	5.0 U	102	70-135	106	70-135	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
n-Propylbenzene	5*	5.0 U	99	70-130	99	70-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
sec-Butylbenzene	5*	5.0 U	103	70-125	106	70-125	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
o-Xylene	5*	NA	NA		NA		NA	NA	NA	NA	NA	NA
Styrene	5*	5.0 U	93	65-135	99	65-135	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
tert-Butylbenzene	5*	5.0 U	101	70-130	104	70-130	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Tetrachloroethene	5*	**2.0 J**	93	45-150	96	45-150	5.0 U	**26**	**25**	**12**	**97**	**50**
Toluene	5*	5.0 U	100	75-120	106	75-120	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
trans-1,2-Dichloroethene	5*	5.0 U	98	60-140	102	60-140	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
trans-1,3-Dichloropropene	0.4**	NA	NA		NA		NA	NA	NA	NA	NA	NA
Trichloroethene	5*	**0.56 J**	93	70-125	97	70-125	5.0 U	**0.61 J**	**0.60 J**	5.0 U	**2.0 J**	**0.86 J**
Trichlorofluoromethane	5*	NA	NA		NA		NA	NA	NA	NA	NA	NA
Vinyl chloride	2	5.0 U	93	50-145	93	50-145	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Xylene (Total)	5*	5.0 U	97	81-121	103	81-121	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U

Notes:

All results are in micrograms per liter (µg/L) or parts per billion (ppb).

Analytical results are compared against NYSDEC Division of Water Technical and Operation Guidance Series (T.O.G.S.) 1.1.1 June 1998 Ambient Water Quality Standards.

NGV - No Guidance Value provided by NYSDEC T.O.G.S. 1.1.1.

NA - Not analyzed.

Bold - Indicates analyte detected by laboratory.

Shaded - Indicates the reported value exceeds the associated T.O.G.S. value.

U - Not detected at laboratory method detection limit.

J - Data indicates the presence of a compound that meets the identification criteria. The result is less than the quantitation limit but greater than MDL. The concentration given is an approximate value.

D - Indicates analysis performed under secondary dilution.

E - Indicates reported concentration was outside calibration limits.

* - Indicates the principal organic contaminant standard for groundwater of 5 µg/L applies to this substance.

** - Applies to the sum of cis- and trans-1,3-Dichloropropene.

^ - Indicates percent recovery was outside of the laboratory quality control limits.

Table 2
Groundwater Analytical Results
VOCs by Method 8260
192 Ralph Avenue Off-Site Plume Trackdown
September 2012, February 2013, and September 2013

	Site ID	MW-5	MW-5	MW-7	MW-7	MW-7	MW-7	MW-7	MW-8	MW-8
	Field Sample ID	MW-5 021313	MW-5 091213	MW-7 021313	MW-7 091013	MW-7 091013DL	Duplicate 01	Duplicate 01DL	MW-8 021313	MW-8 090913
	Sample Date	2/13/2013	9/12/2013	2/13/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	2/13/2013	9/9/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary	Primary	Primary	Dilution	Field Duplicate	Dilution (Field Duplicate)	Primary	Primary
1,1,1-Trichloroethane	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,1,2,2-Tetrachloroethane	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,1,2-Trichloroethane	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,1-Dichloroethene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,2,3-Trichlorobenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,2,3-Trichloropropane	0.04	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,2,4-Trichlorobenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,2,4-Trimethylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,2-Dibromo-3-chloropropane	0.04	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	0.0006	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	3	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,2-Dichloroethane	0.6	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,2-Dichloropropane	1	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,3,5-Trimethylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,3-Dichlorobenzene	3	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,3-Dichloropropane	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,4-Dichlorobenzene	3	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
1,4-Dioxane	NGV	100 UJ	100 U	100 UJ	100 U	200 U	100 U	200 U	100 UJ	100 U
2-Butanone	50	5.0 UJ	5.0 U	5.0 UJ	5.0 U	10 U	5.0 U	10 U	5.0 UJ	5.0 U
4-Isopropyltoluene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
2-Hexanone	50	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	NGV	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Acetone	50	5.0 UJ	5.0 U	5.0 UJ	5.0 U	10 U	5.0 U	10 U	5.0 UJ	5.0 U
Benzene	1	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Bromochloromethane	5*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	50	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromoform	50	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromomethane	5*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	60	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Carbon tetrachloride	5	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Chlorobenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Chloroethane	5*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	7	**2.0 J**	**2.9 J**	**0.69 J**	**0.59 J**	10 U	**0.60 J**	10 U	**5.3**	**3.7 J**
Chloromethane	5*	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	5*	**0.83 J**	**1.6 J**	**2.9 J**	**4.5 J**	**3.9 DJ**	**4.4 J**	**4.2 DJ**	5.0 U	5.0 U
cis-1,3-Dichloropropene	0.4**	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cyclohexane	NGV	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	50	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Dichlorodifluoromethane	5*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Isopropylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
m,p-Xylene	5*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl acetate	NGV	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl tert-butyl ether	10	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Methylcyclohexane	NGV	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methylene chloride	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
n-Butylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
n-Propylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
sec-Butylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
o-Xylene	5*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Styrene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
tert-Butylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Tetrachloroethene	5*	**72**	**140**	**280 D**	**270 E**	**230 D**	**270 E**	**270 D**	**19**	**15**
Toluene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
trans-1,2-Dichloroethene	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
trans-1,3-Dichloropropene	0.4**	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	5*	**1.4 J**	**2.8 J**	**5.9**	**6.1**	**5.2 DJ**	**6.0**	**5.7 DJ**	**0.53 J**	5.0 U
Trichlorofluoromethane	5*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl chloride	2	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U
Xylene (Total)	5*	5.0 U	5.0 U	5.0 U	5.0 U	10 U	5.0 U	10 U	5.0 U	5.0 U

Notes:

All results are in micrograms per liter (µg/L) or parts per billion (ppb).

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E - Indicates reported concentration was outside calibration limits.

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^ - Indicates percent recovery was outside of the laboratory quality control limits.

Table 2
Groundwater Analytical Results
VOCs by Method 8260
192 Ralph Avenue Off-Site Plume Trackdown
September 2012, February 2013, and September 2013

Site ID		MW-9	MW-9	MW-10	MW-10	MW-10		MW-10	
Field Sample ID		MW-9 021313	MW-9 091013	MW-10 021313	MW-10 091013	MW-10 091013		MW-10 091013	
Sample Date		2/13/2013	9/10/2013	2/13/2013	9/10/2013	9/10/2013		9/10/2013	
	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary	Primary	Primary	Matrix Spike		Matrix Spike Duplicate	
Analyte						% Rec.	QC lim.	% Rec.	QC lim.
1,1,1-Trichloroethane	5*	5.0 U	5.0 U	5.0 U	5.0 U	84	65 - 130	87	65 - 130
1,1,2,2-Tetrachloroethane	5*	5.0 U	5.0 U	5.0 U	5.0 U	85	65 - 130	94	65 - 130
1,1,2-Trichloro-1,2,2-trifluoroethane	5*	5.0 U	5.0 U	5.0 U	5.0 U	59 ^	70 - 130	66 ^	70 - 130
1,1,2-Trichloroethane	1	NA	NA	NA	NA	NA		NA	
1,1-Dichloroethane	5*	5.0 U	5.0 U	5.0 U	5.0 U	76	70 - 135	78	70 - 135
1,1-Dichloroethene	5*	5.0 U	5.0 U	5.0 U	5.0 U	75	70 - 130	76	70 - 130
1,2,3-Trichlorobenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	102	55 - 140	104	55 - 140
1,2,3-Trichloropropane	0.04	5.0 U	5.0 U	5.0 U	5.0 U	90	75 - 125	94	75 - 125
1,2,4-Trichlorobenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	93	65 - 135	96	65 - 135
1,2,4-Trimethylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	95	75 - 130	98	75 - 130
1,2-Dibromo-3-chloropropane	0.04	NA	NA	NA	NA	NA		NA	
1,2-Dibromoethane	0.0006	NA	NA	NA	NA	NA		NA	
1,2-Dichlorobenzene	3	5.0 U	5.0 U	5.0 U	5.0 U	97	70 - 120	101	70 - 120
1,2-Dichloroethane	0.6	5.0 U	5.0 U	5.0 U	5.0 U	99	70 - 130	103	70 - 130
1,2-Dichloropropane	1	5.0 U	5.0 U	5.0 U	5.0 U	68 ^	75 - 125	71	75 - 125
1,3,5-Trimethylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	92	75 - 130	96	75 - 130
1,3-Dichlorobenzene	3	5.0 U	5.0 U	5.0 U	5.0 U	94	75 - 125	97	75 - 125
1,3-Dichloropropane	5*	5.0 U	5.0 U	5.0 U	5.0 U	99	75 - 125	98	75 - 125
1,4-Dichlorobenzene	3	5.0 U	5.0 U	5.0 U	5.0 U	93	75 - 125	96	75 - 125
1,4-Dioxane	NGV	100 UJ	100 U	100 UJ	100 U	72	70 - 130	78	70 - 130
2-Butanone	50	5.0 UJ	5.0 U	5.0 UJ	5.0 U	65	30 - 150	65	30 - 150
4-Isopropyltoluene	5*	5.0 U	5.0 U	5.0 U	5.0 U	91	75 - 130	95	75 - 130
2-Hexanone	50	NA	NA	NA	NA	NA		NA	
4-Methyl-2-pentanone	NGV	5.0 U	5.0 U	5.0 U	5.0 U	92	60 - 135	98	60 - 135
Acetone	50	5.0 UJ	5.0 U	5.0 UJ	5.0 U	68	40 - 140	69	40 - 140
Benzene	1	5.0 U	5.0 U	5.0 U	5.0 U	67 ^	80 - 120	68	80 - 120
Bromochloromethane	5*	NA	NA	NA	NA	NA		NA	
Bromodichloromethane	50	NA	NA	NA	NA	NA		NA	
Bromoform	50	NA	NA	NA	NA	NA		NA	
Bromomethane	5*	NA	NA	NA	NA	NA		NA	
Carbon disulfide	60	5.0 U	5.0 U	5.0 U	5.0 U	57	35 - 160	57	35 - 160
Carbon tetrachloride	5	5.0 U	5.0 U	5.0 U	5.0 U	86	65 - 140	88	65 - 140
Chlorobenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	92	80 - 120	96	80 - 120
Chloroethane	5*	NA	NA	NA	NA	NA		NA	
Chloroform	7	**1.2 J**	**0.92 J**	**0.77 J**	**1.6 J**	79	65 - 135	81	65 - 135
Chloromethane	5*	NA	NA	NA	NA	NA		NA	
cis-1,2-Dichloroethene	5*	**3.3 J**	**2.1 J**	5.0 U	5.0 U	69 ^	70 - 125	70	70 - 125
cis-1,3-Dichloropropene	0.4**	NA	NA	NA	NA	NA		NA	
Cyclohexane	NGV	NA	NA	NA	NA	NA		NA	
Dibromochloromethane	50	5.0 U	5.0 U	5.0 U	5.0 U	102	60 - 135	102	60 - 135
Dichlorodifluoromethane	5*	NA	NA	NA	NA	NA		NA	
Ethylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	91	75 - 125	89	75 - 125
Isopropylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	95	75 - 125	94	75 - 125
m,p-Xylene	5*	NA	NA	NA	NA	NA		NA	
Methyl acetate	NGV	NA	NA	NA	NA	NA		NA	
Methyl tert-butyl ether	10	5.0 U	5.0 U	5.0 U	5.0 U	75	65 - 125	78	65 - 125
Methylcyclohexane	NGV	NA	NA	NA	NA	NA		NA	
Methylene chloride	5*	5.0 U	5.0 U	5.0 U	5.0 U	61	55 - 140	64	55 - 140
n-Butylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	85	70 - 135	89	70 - 135
n-Propylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	88	70 - 130	92	70 - 130
sec-Butylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	89	70 - 125	92	70 - 125
o-Xylene	5*	NA	NA	NA	NA	NA		NA	
Styrene	5*	5.0 U	5.0 U	5.0 U	5.0 U	88	65 - 135	88	65 - 135
tert-Butylbenzene	5*	5.0 U	5.0 U	5.0 U	5.0 U	93	70 - 130	96	70 - 130
Tetrachloroethene	5*	**160**	**130**	**12**	**22**	83	45 - 150	80	45 - 150
Toluene	5*	5.0 U	5.0 U	5.0 U	5.0 U	68 ^	75 - 120	71	75 - 120
trans-1,2-Dichloroethene	5*	**1.8 J**	5.0 U	5.0 U	5.0 U	61	60 - 140	63	60 - 140
trans-1,3-Dichloropropene	0.4**	NA	NA	NA	NA	NA		NA	
Trichloroethene	5*	**5.7**	**4.5 J**	5.0 U	5.0 U	69 ^	70 - 125	71	70 - 125
Trichlorofluoromethane	5*	NA	NA	NA	NA	NA		NA	
Vinyl chloride	2	5.0 U	5.0 U	5.0 U	5.0 U	69	50 - 145	72	50 - 145
Xylene (Total)	5*	5.0 U	5.0 U	5.0 U	5.0 U	94	81 - 121	94	81 - 121

Notes:

All results are in micrograms per liter (µg/L) or parts per billion (ppb).

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E - Indicates reported concentration was outside calibration limits.

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Table 2
Groundwater Analytical Results
VOCs by Method 8260
192 Ralph Avenue Off-Site Plume Trackdown
September 2012, February 2013, and September 2013

Site ID		Trip Blank	Trip Blank	Trip Blank	Trip Blank	Trip Blank
Field Sample ID		T. Blank	Trip Blank 021213	Trip Blank 021313	Trip Blank 091013	TB 091213
Sample Date		9/19/2012	2/12/2013	2/13/2013	9/10/2013	9/12/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Trip Blank	Trip Blank	Trip Blank	Trip Blank	Trip Blank
1,1,1-Trichloroethane	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2,2-Tetrachloroethane	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2-Trichloroethane	1	1.0 U	NA	NA	NA	NA
1,1-Dichloroethane	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1-Dichloroethene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2,3-Trichlorobenzene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2,3-Trichloropropane	0.04	NA	5.0 U	5.0 U	5.0 U	5.0 U
1,2,4-Trichlorobenzene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2,4-Trimethylbenzene	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dibromo-3-chloropropane	0.04	1.0 U	NA	NA	NA	NA
1,2-Dibromoethane	0.0006	1.0 U	NA	NA	NA	NA
1,2-Dichlorobenzene	3	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dichloroethane	0.6	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dichloropropane	1	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,3,5-Trimethylbenzene	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U
1,3-Dichlorobenzene	3	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,3-Dichloropropane	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U
1,4-Dichlorobenzene		1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,4-Dioxane	NGV	100 U	100 U	100 U	100 U	100 U
2-Butanone	50	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
4-Isopropyltoluene	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U
2-Hexanone	50	5.0 U	NA	NA	NA	NA
4-Methyl-2-pentanone	NGV	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Acetone	50	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzene	1	0.70 U	5.0 U	5.0 U	5.0 U	5.0 U
Bromochloromethane	5*	1.0 U	NA	NA	NA	NA
Bromodichloromethane	50	1.0 U	NA	NA	NA	NA
Bromoform	50	1.0 U	NA	NA	NA	NA
Bromomethane	5*	1.0 U	NA	NA	NA	NA
Carbon disulfide	60	1.0 U	**1.1 J**	5.0 U	5.0 U	5.0 U
Carbon tetrachloride	5	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chlorobenzene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chloroethane	5*	1.0 U	NA	NA	NA	NA
Chloroform	7	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chloromethane	5*	1.0 U	NA	NA	NA	NA
cis-1,2-Dichloroethene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
cis-1,3-Dichloropropene	0.4**	1.0 U	NA	NA	NA	NA
Cyclohexane	NGV	1.0 U	NA	NA	NA	NA
Dibromochloromethane	50	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Dichlorodifluoromethane	5*	1.0 U	NA	NA	NA	NA
Ethylbenzene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Isopropylbenzene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
m,p-Xylene	5*	1.0 U	NA	NA	NA	NA
Methyl acetate	NGV	1.0 U	NA	NA	NA	NA
Methyl tert-butyl ether	10	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylcyclohexane	NGV	1.0 U	NA	NA	NA	NA
Methylene chloride	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
n-Butylbenzene	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U
n-Propylbenzene	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U
sec-Butylbenzene	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U
o-Xylene	5*	1.0 U	NA	NA	NA	NA
Styrene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
tert-Butylbenzene	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U
Tetrachloroethene	5*	1.0 U	5.0 U	5.0 U	**1.8 J**	**1.2 J**
Toluene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
trans-1,2-Dichloroethene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
trans-1,3-Dichloropropene	0.4**	1.0 U	NA	NA	NA	NA
Trichloroethene	5*	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Trichlorofluoromethane	5*	1.0 U	NA	NA	NA	NA
Vinyl chloride	2	1.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Xylene (Total)	5*	NA	5.0 U	5.0 U	5.0 U	5.0 U

Notes:

All results are in micrograms per liter (µg/L) or parts per billion (ppb).

Analytical results are compared against NYSDEC Division of Water Technical and Operation Guidance Series (T.O.G.S.) 1.1.1 June 1998 Ambient Water Quality Standards.

NGV - No Guidance Value provided by NYSDEC T.O.G.S. 1.1.1.

NA - Not analyzed.

Bold - Indicates analyte detected by laboratory.

Shaded - Indicates the reported value exceeds the associated T.O.G.S. value.

U - Not detected at laboratory method detection limit.

J - Data indicates the presence of a compound that meets the identification criteria. The result is less than the quantitation limit but greater than MDL. The concentration given is an approximate value.

D - Indicates analysis performed under secondary dilution.

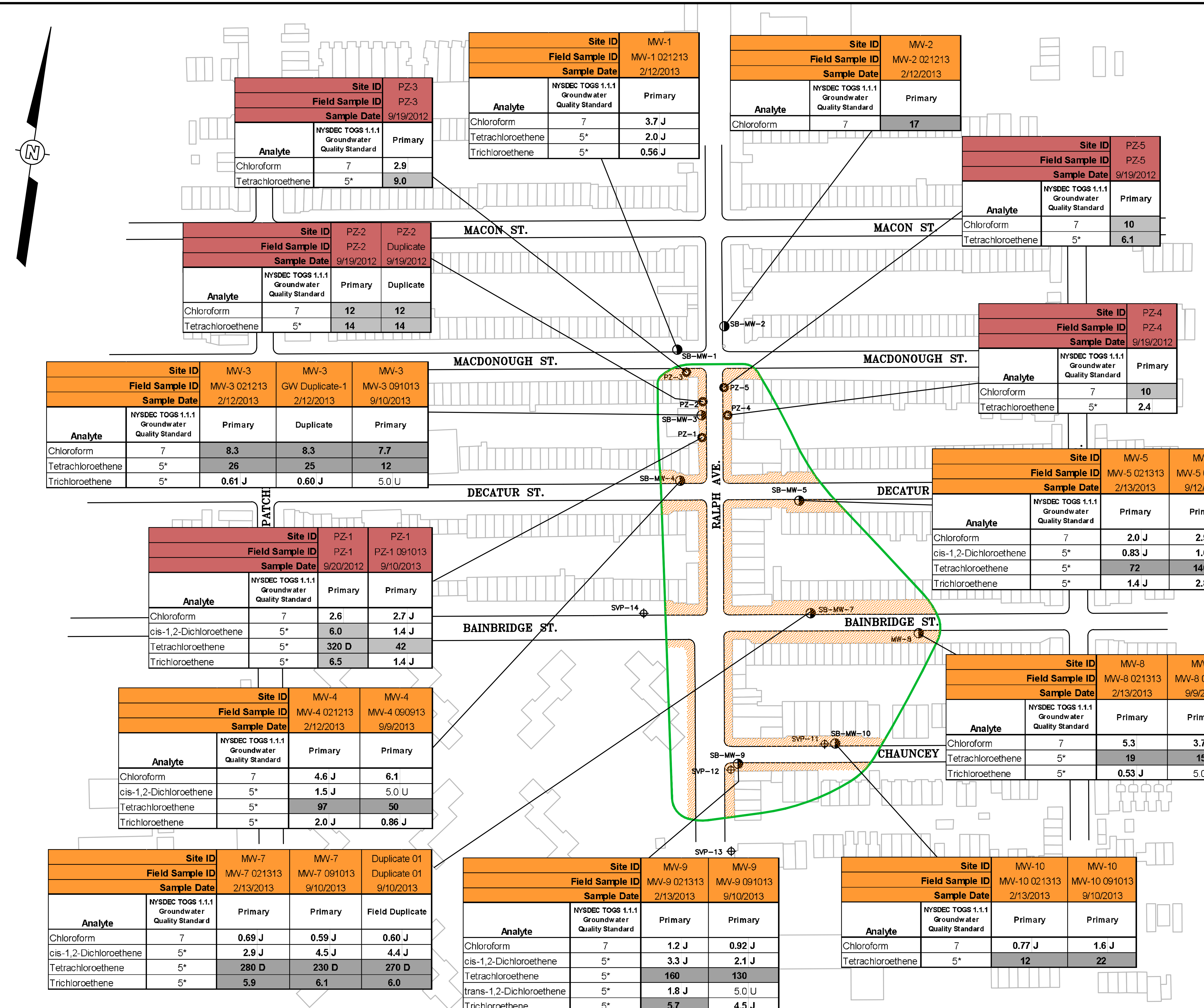
E - Indicates reported concentration was outside calibration limits.

* - Indicates the principal organic contaminant standard for groundwater of 5 µg/L applies to this substance.

** - Applies to the sum of cis- and trans-1,3-Dichloropropene.

^ - Indicates percent recovery was outside of the laboratory quality control limits.

Figure 1



Site ID		PZ-3
Field Sample ID		PZ-3
Sample Date		9/19/2012
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	2.9
Tetrachloroethene	5*	9.0

Site ID		MW-1
Field Sample ID		MW-1 021213
Sample Date		2/12/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	3.7 J
Tetrachloroethene	5*	2.0 J
Trichloroethene	5*	0.56 J

Site ID		MW-2
Field Sample ID		MW-2 021213
Sample Date		2/12/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	17

Site ID		PZ-5
Field Sample ID		PZ-5
Sample Date		9/19/2012
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	10
Tetrachloroethene	5*	6.1

Site ID		PZ-2	PZ-2
Field Sample ID		PZ-2	Duplicate
Sample Date		9/19/2012	9/19/2012
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Duplicate
Chloroform	7	12	12
Tetrachloroethene	5*	14	14

Site ID		PZ-4
Field Sample ID		PZ-4
Sample Date		9/19/2012
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary
Chloroform	7	10
Tetrachloroethene	5*	2.4

Site ID		MW-3	MW-3	MW-3
Field Sample ID		MW-3 021213	GW Duplicate-1	MW-3 091013
Sample Date		2/12/2013	2/12/2013	9/10/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Duplicate	Primary
Chloroform	7	8.3	8.3	7.7
Tetrachloroethene	5*	26	25	12
Trichloroethene	5*	0.61 J	0.60 J	5.0 U

Site ID		MW-5	MW-5
Field Sample ID		MW-5 021313	MW-5 091213
Sample Date		2/13/2013	9/12/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	2.0 J	2.9 J
cis-1,2-Dichloroethene	5*	0.83 J	1.6 J
Tetrachloroethene	5*	72	140
Trichloroethene	5*	1.4 J	2.8 J

Site ID		PZ-1	PZ-1
Field Sample ID		PZ-1	PZ-1 091013
Sample Date		9/20/2012	9/10/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	2.6	2.7 J
cis-1,2-Dichloroethene	5*	6.0	1.4 J
Tetrachloroethene	5*	320 D	42
Trichloroethene	5*	6.5	1.4 J

Site ID		MW-8	MW-8
Field Sample ID		MW-8 021313	MW-8 090913
Sample Date		2/13/2013	9/9/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	5.3	3.7 J
Tetrachloroethene	5*	19	15
Trichloroethene	5*	0.53 J	5.0 U

Site ID		MW-4	MW-4
Field Sample ID		MW-4 021213	MW-4 090913
Sample Date		2/12/2013	9/9/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	4.6 J	6.1
cis-1,2-Dichloroethene	5*	1.5 J	5.0 U
Tetrachloroethene	5*	97	50
Trichloroethene	5*	2.0 J	0.86 J

Site ID		MW-7	MW-7	Duplicate 01
Field Sample ID		MW-7 021313	MW-7 091013	Duplicate 01
Sample Date		2/13/2013	9/10/2013	9/10/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary	Field Duplicate
Chloroform	7	0.69 J	0.59 J	0.60 J
cis-1,2-Dichloroethene	5*	2.9 J	4.5 J	4.4 J
Tetrachloroethene	5*	280 D	230 D	270 D
Trichloroethene	5*	5.9	6.1	6.0

Site ID		MW-9	MW-9
Field Sample ID		MW-9 021313	MW-9 091013
Sample Date		2/13/2013	9/10/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	1.2 J	0.92 J
cis-1,2-Dichloroethene	5*	3.3 J	2.1 J
Tetrachloroethene	5*	160	130
trans-1,2-Dichloroethene	5*	1.8 J	5.0 U
Trichloroethene	5*	5.7	4.5 J

Site ID		MW-10	MW-10
Field Sample ID		MW-10 021313	MW-10 091013
Sample Date		2/13/2013	9/10/2013
Analyte	NYSDEC TOGS 1.1.1 Groundwater Quality Standard	Primary	Primary
Chloroform	7	0.77 J	1.6 J
Tetrachloroethene	5*	12	22

LEGEND

- MW-5 MONITOR WELL
- PZ-3 PIEZOMETER
- MONITOR WELL VOC DETECTIONS
- PIEZOMETER VOC DETECTIONS
- AREA OF PLUME TO BE TREATED
- LOCATION OF INJECTION WELLS

NOTES:

1. North orientation and coordinates are referenced to Grid North and are based on the New York State Plane Coordinate System, Long Island Zone, NAD 83 obtained from GPS observations made on February 20, 2013 and
2. All analytical results are in micrograms per liter (ug/L) or parts per billion (ppb).

SCALE

0 200 400 FEET

URS Corporation

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
192 RALPH AVENUE OFF-SITE PLUME TRACKDOWN

FIGURE 5-3
ALTERNATIVE 4 TREATMENT LOCATION

192 RALPH AVE
BROOKLYN, NEW YORK

File: J:\Projects\60508882_ralphavefs\900-CAD-GIS\910-CAD\CAD\FIGURE 5-3.dwg
Plot Date/Time: Jun 06, 2017 - 11:56am
Plotted By: rick.lecksell
Xref:
Image: 192 RALPH AVE.jpg

APPENDIX B

COST ESTIMATES

192 Ralph Ave FS

Permanganate Injection

192 Ralph Ave FS

Construction Cost Estimate

DRAFT

by: RJP 06/27/17

ckd by: AJZ 06/27/17

CAPITAL COST ITEMS

ITEM NO.	DESCRIPTION	UNIT	UNIT PRICES: UNIT PRICE FROM ATTACHED BACK-UP	ALT 2: EST QTY	ALT 2: TOTAL PRICE ($)	ALT 3: EST QTY	ALT 3: TOTAL PRICE ($)	ALT 4: EST QTY	ALT 4: TOTAL PRICE ($)
UC-1	Site Services	Day	NA	0	$ -	1	$ 83,743	1	$ 230,642
UC-2	Injection Well Installation	LF	$ 150	0	$ -	3,000	$ 450,000	7,500	$ 1,125,000
UC-3	Sodium Permanganate Injection (10% Solution)	Gallon	$ 6.50	0	$ -	155,890	$1,013,285	483,542	$ 3,143,023
UC-4	Health and Safety	Day	$ 250	0	$ -	245	$ 61,250	618	$ 154,500
LS-1	Mob/Demob & Site Prep	Lump Sum	NA	1	$ -	1	$ 83,743	1	$ 230,642
LS-2	Site Survey	Lump Sum	varies	0	$ -	1	$ 60,000	1	$ 100,000
LS-3b	Performance Monitoring	Lump Sum	varies	0	$ -	1	$ 77,319	1	$ 77,319
			SUBTOTAL		$ -		$1,829,339		$ 5,061,126
			CONTINGENCY (15% of Subtotal)		$ -		$ 274,401		$ 759,169
			GRAND TOTAL		$ -		$2,103,740		$ 5,820,295

Highlighted item = 5% of total of all non-hilighted items

O&M ITEMS

LS-3a	Baseline Monitoring	Lump Sum	$ 13,000	1	$ 13,000	1	$ 13,000	1	$ 13,000

Bases

(1) Baseline Monitoring - Baseline monitoring shall be performed prior to any injection and performance monitoring. Also perform baseline monitoring for Alt 2 - Institutional Controls only.

(2) Performance Monitoring - After each injection event, perform 5 rounds of monitoring to consist of one round per each of 5 months then a 6th round/month (just prior to the next injection event) that shall also include monitoring of VOCs, metals and alkalinity.

(3) Injection Events - Two (2) injection events shall be performed for Alts 3 and 4.

0 $ -

(4) Permanganate - Inject at 10% solution.

0

(5) Injection Well Type and Depth: Assume all wells are 60 feet deep and "singles" (i.e., not nests of two or three at variable screen depths).

2-inch diam Sch 40 PVC casing

Sch 40 PVC continuous wrap screen, approx 20 ft long

Flush mount road box at surface

(6) Monitoring Wells:

> There will be no new monitoring wells constructed for any Alt

> There are nine (9) existing monitoring wells and these will be the only wells monitored for all Alts.

> 8-inch diam bore hole

192 Ralph Ave FS

Permanganate Injection

	By: RJP	Cked By: AJZ
	Date: 6/27/2017	Date: 6/27/2017

Bid Item	**Description of Bid Item**	**Unit of Measure**
UC-1	Site Services	Day

Limited to 5% of bid amount per Measurement and Payment spec

Total of cost items exclusive of

	UC-1	Site Services
and	LS-1	Mob/Demob & Site Prep

which are the two "limited to 5% of bid amount items"

192 Ralph Ave FS

Permanganate Injection

By:	RJP	Cked By:	AJZ
Date:	6/27/2017	Date:	6/27/2017

Bid Item	Description of Bid Item	Unit of Measure
UC-2	Well Installation	LF

2017 project in Brooklyn for installing 18 borings using sonic method @ 70 LF = 1,260 LF. Work included mob/demob, permits, 2-in diameter Sch 40 PVC screen and casing, road box surface, containerize cuttings and water/move drums, well development, decon, and grout.

Cost was $177,000, which equates to $140/LF.

Injection Well Quantity:

	# Wells	Length (LF)	Total (LF)
Alt 2	0	NA	0
Alt 3	50	60	3,000
Alt 4	125	60	7,500

say $ 150 per LF

192 Ralph Ave FS

Permanganate Injection

By:	RJP	Cked By:	AJZ
Date:	6/27/2017	Date:	6/27/2017

Bid Item	Description of Bid Item	Unit of Measure
UC-3	Sodium Permanganate Injection (10% Solution	Gallon

(1) Recent Carus quote (below) for 10% permanganate delivered	$5.50	per gallon
(2) Labor Add for injection	$1.00	per gallon
TOTAL	$6.50	per gallon

(1) Material Cost Delivered at 10% Solution

Reference Carus 2017 Quotes.

Assumes shipped to local "tolling partner" at 40% solution that will deliver it to site at 10% solution.

Alternate 3 is grand total 156,000 gallons divided into two injection events of 78,000 gallons each event - so for each injection event this would translate to 20 truckloads (over 33 days per Tab "UC-4".).

(78,000 gallons)/(4,000 gallon truck) = 20 truckloads.

So this is roughly one truck load every 1-1/2 days.

Price Quote of $412,723 for 78,000 gallons = $ 5.29 per gallon

Alternate 4 is grand total 485,000 gallons divided into two injection events of 243,000 gallons each event - so for each injection event this would translate to 60 truckloads (over 107 days per Tab "UC-4").

(243,000 gallons)/(4,000 gallon truck) = 60 truckloads.

So this is roughly one truck load every 2nd day.

Price Quote of $1,256,689 for 243,000 gallons = $ 5.17 per gallon

(2) Labor Cost Per Gallon:

Ref. Tab "Table 1" for manhours required to inject permanganate.

Use Alt 3, for example, it takes 467 manhours per each of two injection events, or total of (467 x 2 =) 934 manhours to inject 155,890 gallons of 10% solution.

Thus, 934 manhours x $100/hour = $93,400

div by 155,890 gallons = $0.60/gallon

Use $1.00 per gallon for labor.

192 Ralph Ave FS

Permanganate Injection

By:	RJP	Cked By:	AJZ
Date:	6/27/2017	Date:	6/27/2017

Bid Item	Description of Bid Item	Unit of Measure
UC-4	Health and Safety	Day

Ref. vendor quote (attached) from similar project/location and construct 60 wells.

$ 250 per day

Basis was for 300 days to address well construction plus 2 to 3 injection events.

On site effort will be required to construct injection wells, inject wells, and for monitoring.

(1) Injection Well Construction.

It takes 3 days to install each 60-foot well: 2 days to install plus one day to develop.

Alt 3: So 50 wells takes 150 days. Include mob/demob, say: 155 days

Alt 4: So 125 wells takes 375 days. Include mob/demob, say: 380 days

(2) Well Injection (There will be 2 injection events for Alts 3 and 4)

Ref Tab "Table 1" for manhours per each injection event, for 2-man crew.

Alt 2	(no injections)	
Alt 3	467 manhours ... div by 2 men ... div by 7hrs/day =	33 days (or 66 days for 2 events)
Alt 4	1,500 manhours ...div by 2 men ...div by 7hrs/day =	107 days (or 214 days for 2 events)

(3) Performance/Baseline Monitoring: (Ref Tab "Table 2")

	# trips	# days per trip	Total days
Alt 2	1	2	2
Alt 3	12	2	24
Alt 4	12	2	24

(4) Grand Total (1) thru (3) Above:

Alt 2	2	(no well constr or injections for Alt 2)
Alt 3	245	(155 plus 66 plus 24)
Alt 4	618	(380 plus 214 plus 24)

192 Ralph Ave FS

Permanganate Injection

By: RJP	Cked By: AJZ
Date: 6/27/2017	Date: 6/27/2017

Bid Item	Description of Bid Item	Unit of Measure
LS-1	Mob/Demob & Site Prep	Lump Sum

Limited to 5% of bid amount per Measurement and Payment spec

Total of cost items exclusive of

	UC-1	Site Services
and	LS-1	Mob/Demob & Site Prep

which are the two "limited to 5% of bid amount items"

192 Ralph Ave FS

Permanganate Injection

	By: RJP	Cked By AJZ
	Date: 6/27/2017	Date: 6/27/2017

Bid Item	**Description of Bid Item**	**Unit of Measure**
LS-2	Site Survey	Lump Sum

Refer to attached price quote from Naik Group from 2010 project which is for the following:

Services include the following:

1. Establish survey control
2. Pre-stakeout of 60 wells
3. Surficial features locating
4. Public right-of-ways
5. Locate as-built x-y-z of constructed wells
6. Base map preparation
7. "Normal" constr. Coord. with Prime Contractor, Engineer, and Municipalities
8. Typical construction submittals such as electronic files and field notes

Cost Quote = $57,900 for 60 wells and misc

Say	$	5,000	Alt 2 (9 wells)
Say	$	60,000	Alt 3 (50 wells)
Say	$	100,000	Alt 4 (125 wells)

192 Ralph Ave FS

Permanganate Injection

By:	RJP	Cked By:	AJZ
Date:	6/27/2017	Date:	6/27/2017

Bid Item	**Description of Bid Item**	**Unit of Measure**
LS-3a	Baseline Monitoring	Lump Sum

Field Effort:

For 192 Ralph Avenue site, cost per trip:

(a) LABOR: Monitoring manhours for 9 locations: (2 people x 2 days x 12 hrs/day =) 48 hrs per trip

Assume local crew. x $100/ $ 4,800 (a)

(b) EQUIP RENTAL and SAMPLE PICK-UP:

Equipment Rental (for 2 days):	Rate	No.	Total
Water level meter	$ 25	2	$ 50
Field parameters	$ 125	2	$ 250
Tubing (540 LF)	$ 850	ump sur	$ 850
Colorimeter	$ 30	2	$ 60
Turbidity meter	$ 25	2	$ 50
Bladder pump	$ 50	2	$ 100
Compressor/controller for bladder	$ 80	2	$ 160
Nitrile gloves	$ 15	ump sur	$ 15
PID rental	$ 75	2	$ 150
			$ 1,685
SubTotal			$ 6,485 per trip
Courier cost for lab to pick up samples from site			$ 200
Total			$ 6,685 (b)
		Say field eff	$ 11,485 per trip

Equipment rental prices assumes/includes equipment being delivered to site.

(continued)

192 Ralph Ave FS

Permanganate Injection

By: RJP	Cked By: AJZ
Date: 6/27/2017	Date: 6/27/2017

Bid Item	**Description of Bid Item**	**Unit of Measure**
LS-3a	Baseline Monitoring	Lump Sum

Lab Effort:

See Tab "Lab Unit Prices" for lab costs

	2017	No.	Cost
Average cost for:			
TCL VOC by SW846-8260B	$ 71		
TAL Metals by SW846-6010B/7470A/7471A	$ 102		
Alkalinity by EPA 310	$ 14		
	$ 187	9	$ 1,683
Lab Color by SM 2120B	$ 12	9	$ 108
Total			$ 1,791
		say	$ 1,800
		per trip	lab cost

Total Field plus Lab $ 13,285

say $ 13,000 per trip

192 Ralph Ave FS

Permanganate Injection

By:	RJP	Cked By:	AJZ
Date:	6/27/2017	Date:	6/27/2017

Bid Item	**Description of Bid Item**	**Unit of Measure**
LS-3b	Performance Monitoring	Lump Sum

Ref. Tab "Table 2" for requirements.

Field Effort:

Performance monitoring field effort will be same as baseline monitoring (same # wells/samples). Thus use baseline monitoring field cost to represent performance monitoring cost:

	# Trips	Cost ($ 7,000 per trip)	Field Total	Lab (below)	Total, Field plus Lab
Alt 2	0	$ 7,000	$ -	0	$ -
Alt 3	11	$ 7,000	$ 77,000	$ 319	$ 77,319
Alt 4	11	$ 7,000	$ 77,000	$ 319	$ 77,319

Lab Effort:

See Tab "Lab Unit Prices" for lab costs

Average cost for:	2017	No.	Cost
TCL VOC by SW846-8260B	$ 71	1	$ 71
TAL Metals by SW846-6010B/7470A/7471A	$ 102	1	$ 102
Alkalinity by EPA 310	$ 14	1	$ 14
Lab Color by SM 2120B	$ 12	11	$ 132
			$ 319

192 Ralph Ave FS

Permanganate Injection

By:	GK	RJP
Date:	6/8/2017	6/27/2017

Lab Unit Prices

		2013*	2017
Average cost for:			
TCL VOC by SW846-8260B	=	$ 67	$ 71
TAL Metals by SW846-6010B/7470A/7471A	=	$ 96	$ 102
Alkalinity by EPA 310	=	$ 13	$ 14
Total		$176	$ 187
Lab Color by SM 2120B		$11	$ 12

(Add sample frequency of 5% for Baseline testing for MS/MSD's ... i.e., 5% mark-up)

Average Turnaround Time premium

24 hour = 89%

48 hour = 62%

72 hour = 40%

1 week = 18%

2 week = 7%

* 2013 averages based on 9 bid responses for NYSDEC Standby Contract D007622, May 2011, rounded up to the nearest dollar. Prices for soil and water are the same.
NYSDEC ASP Category B deliverables

by: RJP 06/27/17
ckd by: AJZ 06/27/17

Injection Manhours

Alternative 3							
		# of Injection Wells	Volume 10% Permanganate Solution, All Events in Total (Gal)	@ 8 gpm required injection hrs per well (Hrs)	Productivity Reduction	# of Injection Events	Manhours per Injection Event (assume 2 person crew)
		50	155,890	7	0.75	2	467

Alternative 4							
		# of Injection Wells	Volume 10% Permanganate Solution, All Events in Total (Gal)	@ 8 gpm required injection hrs per well (Hrs)	Productivity Reduction	# of Injection Events	Manhours per Injection Event (assume 2 person crew)
		125	483,542	9	0.75	2	1,500

by: RJP 06/27/17
ckd by: AJZ 06/27/17

Monitoring Schedule

	BASELINE	PERFORMANCE (11 Trips for Alts 3 and 4; no trips for Alt 2)										
Frequency of Groundwater Sample Collection	Baseline Monitoring Prior to 1st Injection Event	Post-Injection Monitoring					Prior to 2nd Injection Event	Post-Injection Monitoring				
Parameters		Month 1	Month 2	Month 3	Month 4	Month 5	Month 6 (approx)	Month 1	Month 2	Month 3	Month 4	Month 5
LAB: VOCs, Metals, Alkalinity	x						x					
LAB: Color	x	x	x	x	x	x	x	x	x	x	x	x
FIELD Parameters (pH, DO, ORP, Specific Conductivity)	x	x	x	x	x	x	x	x	x	x	x	x

Prior to Injection Events	# Wells			Total # of Samples	Total # of Sample Locations
Baseline Monitoring Wells		9		9	9
Alternative 2 Mon Wells		9		9	9
Alternative 3 Mon Wells		9		9	9
Alternative 4 Mon Wells		9		9	9

Cost-Plus-Fixed-Fee Subcontract
Standby Contract C007540

Name of Subcontractor	Service to be Performed	Subcontract Price
Naik Consulting Consulting Group, P.C. (MBE)	Land Survey & Drawing as work assignments are provided	$57,898.44

A) Direct Salary Costs

Professional Responsibility Level	Labor Classificat	Ave. Reimbursement Rate ($/Hr.)	Est. No. of Hours	Total Est. Direct Salary Cost (Ave. Reimb. Rate x Est. # of Hrs.)
Project Manager	A VII	$50.00	34	$1,700.00
Engineer	A V	$42.00	76	$3,192.00
Surveyor / Party Chief	A III	$31.67	232	$7,347.44
CADD Manager	N III	$31.20	27	$842.40
CADD Technician	N II	$28.00	87	$2,436.00
Instrument Technician	N II	$25.50	232	$5,916.00
Engineering Tech	N I	$21.16	0	$0.00
Total Direct Salary Costs				$21,433.84

Footnotes:

1) These rates will be held firm until December 31, 2010

2) Reimbursement will be limited to the lesser of either the individuals actual hourly rate or the maximum for each labor category.

3) Reimbursement will be limited to the maximum reimbursement rate for the professional responsibility level of the actual work performed.

4) Only those labor classifications indicated with an asterisk will be entitled to overtime premium.

5) Reimbursement for technical time of principals, owners, and officers will be limited to the maximum reimbursement rate of that labor category, the actual hourly labor rate paid, or the State M-6 rate, whichever is lower.

6) The maximum rates in each labor category can be modified only by mutual written agreement and approved by both the Department and the Comptroller.

7) This footnote applies to Schedules for year 2 thru 7 only. If the U.S. cost-of-living index increases at a rate greater than 5% compounded annually, the maximum salary rates will be subject to renegotiation for future years of the contract. There shall be no retroactive adjustments of payment as a result of renegotiated salary schedules.

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B) Indirect Costs

Indirect costs shall be paid based on a percentage of direct salary costs incurred which shall not exceed a maximum of 127.06 % or the actual rate calculated in accordance with 48 CFR Federal Acquisition Regulation, whichever is lower.

Amount budgeted for indirect costs is: $27,233.84

C) Maximum Reimbursement Rates for Direct Non-Salary Costs

Item	Max. Reimbursement Rate (Specify Unit)	Est. No. Of Units	Total Est. Cost
1 Overnight mailings, Parking & Tolls at th w/receipts			$1,000.00
2 Average State Mandated Supplemental Benefit			$0.00
for field personnel is $7.25/hour			$3,364.00
			$0.00
			$0.00
			$0.00
Total Direct Non-Salary Costs			$4,364.00

D) Fixed Fee

The Fixed fee is: 10 % $4,866.77

See Schedule 2.10(h) for how the fixed fee should be claimed.